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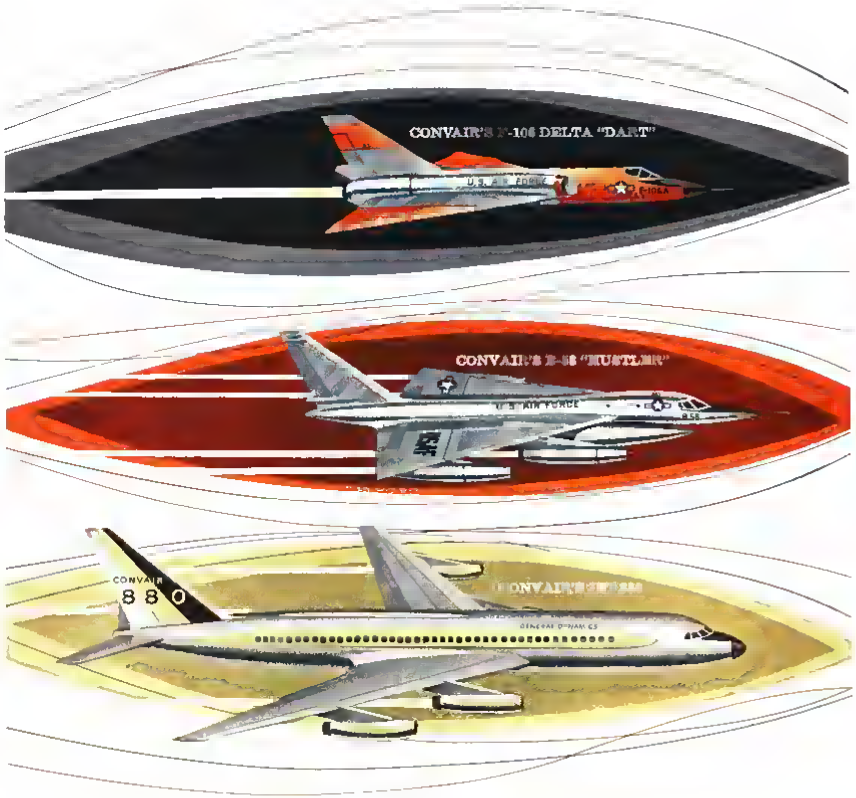

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AVIATION WEEK and Space Technology
March 7, 1960
Vol. 72 No. 10

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A GOOD RUN FOR YOUR MONEY—

New "SCOTCH" BRAND Heavy Duty Tapes offer exceptional life, low rub-off, good resolution

HAVE PROBLEMS OF TAPE LIFE, rub off and resolution? To cure your headaches in applications that subject magnetic tape to high speeds, pressures, temperatures and low humidity, "SCOTCH" BRAND now prescribes two new tapes—Heavy Duty Tapes 198 and 199. They offer plus-performance in a wide variety of temperature and humidity conditions.

Take the matter of wear...for instance. Field tests show that "SCOTCH" BRAND Heavy Duty Tapes wear five times longer than standard tapes—yet they maintain good resolution and freedom from drop-outs over this long haul. Two factors are decisive in this performance—resistance to rub off and resistance to high temperatures.

Ordinary tapes age fast if the temperature climbs or the relative humidity drops sharply. The binder softens, allowing the oxides to rub off on those costly and sensitive heads. Further, as an electrostatic charge builds with each pass, stray contaminants are attracted to the tape—and the tape starts to cling to the equipment. In each case—your drop-out count mounts.

Not so with "SCOTCH" BRAND Heavy Duty Tapes. They boast an extra tough binder system similar to that used in "SCOTCH" BRAND Video Tape, which after two years is still the only video tape in commercial use. The heavy duty binder system anchors the oxides firmly to the polyester base in a way that resists very high temperatures—minimizing rub-off. Moreover, Heavy Duty Tapes have a conductivity nearly 1000 times greater than conventional tapes, allowing static charge to drain off. Result? Clean, smooth runs with good resolution—a good run for your money.

Performance of this kind is easy to promise—much harder to deliver. And only experienced "SCOTCH" BRAND technology has such a record of delivering the right tape for every application in data acquisition, reduction or control programming.

Check all the tapes in the "SCOTCH" BRAND line. High Resolution Tapes 158 and 159 pack more bits per inch, offer extra play time. High Output Tape 128 gives top output in low frequencies, even in temperature extremes. Sandwich Tapes 188 and 189 drastically cut head-wear, eliminate oxide rub-off, and wear 10 times longer than ordinary tapes. Standard Tapes 108 and 109 remain the standard of instrumentation.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details consult him or write Magnetic Products Div., 3M Co., St. Paul 6, Minn.

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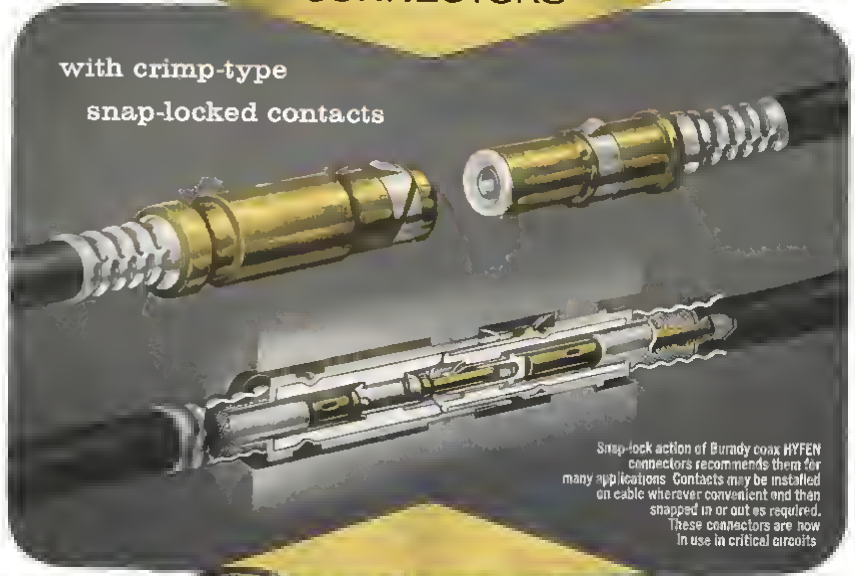
with crimp-type snap-locked contacts



Snap-lock action of Burndy coax HYFEN connectors recommends them for many applications. Contacts may be installed on cable wherever convenient and then snapped in or out as required. These connectors are now in use in critical circuits.

ME7X
...Rack-and-panel Coax HYFEN with one-piece die-cast shell and one-piece block. Mates with existing solder types.

COAX MODULOK
... Modular terminal block. Modules snap together or apart and are mounted on cadmium-plated steel track.

CONNECT QUICKLY
...High speed tooling for volume production results in low installed costs.

CONNECT EASILY
... snap-lock action and simple design with few parts make installation easy—tool crimps contacts in any circumferential position.

CONNECT RELIABLY
...tool controlled crimp provides strain relief for conductors, guarantees a uniform indent for measurable quality control. There is no heat to damage insulation.

FOR OTHER REQUIREMENTS OR APPLICATIONS CONTACT BURNDY DIVISION

BURNDY

Norwalk, Connect. In Europe: Antwerp, Belgium Toronto, Canada

SAC has a Hound Dog that can slalom in the sky

SAC's GAM-77 HOUND DOG air-to-ground missile has a built-in artifice. It can feint at pseudo-targets before turning toward its real objective. This dog-leg "slalom" approach is made possible by an inertial navigation system that is immune to enemy decoying and jamming.

Speed and altitude variations can also be programmed into the HOUND DOG's target approach. This gives the GAM-77 even greater versatility for penetrating an enemy's defenses.

Armed with a HOUND DOG under each wing, a SAC B-52 bomber attains triple-threat capability. From a distance of hundreds of miles, enemy resistance posts can be obliterated while the B-52 wings its internal bomb load to destination. As an alternative, the supersonic HOUND DOGS can be sent right in on the main target itself.

Alternate HOUND DOGS are now being assigned to Air Force "Blue Suit Integration" crews for training use. In combination with SAC's B-52 intercontinental bombers, they materially enhance America's strategic air power.

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.
Downey, California

The little booklet on alloy steels that grew into a textbook . . .

Quick Facts about Alloy Steels appeared for the first time in 1956 as a collection of reprints of a series of Bethlehem advertisements in metalworking magazines.

The small booklet was well received, and we kept adding more of the informative advertisements as we reprinted it to keep up with demand. Today, it has grown to 40-page size, and is in its Third Edition. More than 20,000 booklets have been distributed at the written request of executives, engineers, designers, and others, who have found *Quick Facts* to be an authoritative small textbook on the fundamentals of alloy steels. Here's what a U. S. Navy engineer wrote:

"*Quick Facts* is a small textbook of information—a booklet that has been needed for a long time. One of my associates and I had a metallurgical problem involving alloy steels. We just didn't have the information. A friend showed me a copy of your booklet *Quick Facts*, and there on one page, under the subject 'Determining Depth Hardness,' was just what we wanted to know!"

The current booklet contains reprints of the complete series of advertisements, on such subjects as, "What is an Alloy Steel?" "Effects of Elements," "Grain Size," "Heat-treatment," "Quenching Media," and others. It's written in concise layman's language, from data compiled by Bethlehem's metallurgical engineers.

Would you like a copy of the *Quick Facts* booklet? Just fill out and send in the coupon.

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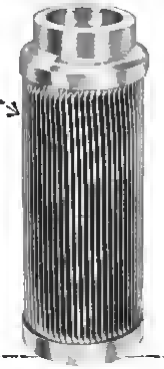
- Meets requirements of specifications MIL-F-5504B and the proposed MIL-F-8815.



Only Pressure Lock will do it, and this is why.

Pressure Lock is an exclusive Purolator process of assembling a wire-mesh filter medium without welding, brazing or cementing, and without the contamination that any of these methods produce. Pressure Lock embeds the filter medium in the end caps in an absolute bond that contains no material other than the metal of the cap and filter medium. As a result, the only limitation on the performance of a Pressure Lock filter — temperature, pressure, vibration, filtration or weight — is the physical properties of the construction metals.

Present ratings are for a nominal 10 micron (absolute maximum particle size of 25 microns) and for a nominal 5 micron (absolute maximum particle size of 15 microns), in capacities of ¾, 3, 6 and 12 GPM. Higher capacity elements are being processed for early production.

The Pressure Lock process provides literally a new standard for filter applications in aircraft and missiles, industrial hydraulics, pneumatics and chemical process industries. Fill in the coupon and send it now for further information.

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Dept. 108, Rahway, New Jersey
Please send complete data on Purolator filters with Pressure Lock elements.

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Ever since man discovered the wheel, he has been working at new ways to use it. The latest use of the wheel is in the jet turbine. These turbine wheels and compressor wheels, forged in massive closed dies from materials unknown a few years ago, make possible the outstanding performance records of our American engines.

Helping wheels turn—on the ground—on the sea—in space—is all part of Wyman-Gordon's business. Where performance depends upon stamina, there is no substitute for a forging—and in a forging there is no substitute for Wyman-Gordon experience, quality and dependability.

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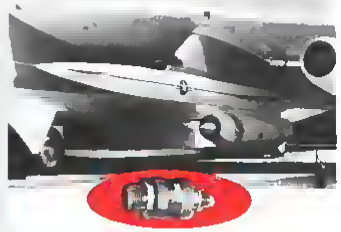

The Air Force's new Hound Dog missile is equipped with Aeroquip Quick-Disconnect Couplings. Both handling and checkout of the hydraulic systems are facilitated through the use of this coupling on the missile's internal system and ground service checkout equipment.

Space and weight are at a premium on the Quail. To save space, yet retain complete reliability, Aeroquip 1010 Series Quick-Disconnect Couplings are specified. These Self-Sealing Couplings are used in the fuel, lube oil and pneumatic systems of the compact Quail.

The Navy's new supersonic missile, the Corvus, is rocket powered. This swift air-to-ground weapon is equipped with a special Aeroquip Quick Disconnect Coupling used as an umbilical disconnect. This coupling was especially designed for the Corvus by Aeroquip.

Unlimited Coupling Designs for Unlimited Missile Applications

The rapid advance of U.S. missile technology sets continually new requirements for the development of fluid system quick-disconnect couplings. With the largest and most experienced engineering staff in the industry, Aeroquip has designed and manufactured special purpose couplings for many leading missile system contractors. Aeroquip can solve your coupling problems, too. Aeroquip can design and produce a quick disconnect coupling to fit unusual or complicated applications with minimum lead time.

Couplings also are available now in many standardized designs and sizes. In many cases this wide selection means quick delivery of a coupling that meets your requirements. For complete information and assistance mail the coupon below.

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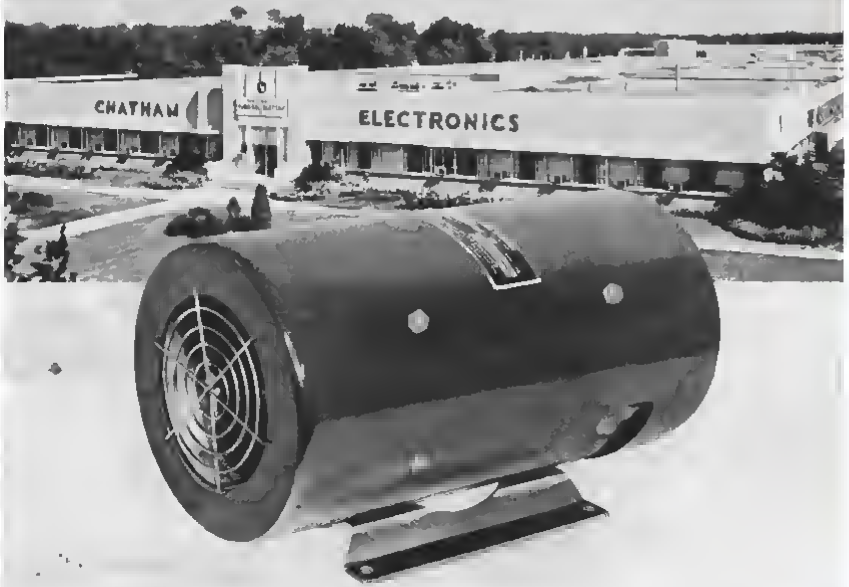
NEW CHATHAM Y-SERIES

Airborne Transformer Rectifiers



. . . lightest, smallest of them all

Chatham's new bantamweight Y-Series transformer rectifiers weigh up to ⅗ less than competitive models with comparable ratings And they occupy just ¼ the volume

These precision miniatures in Chatham's series are rated from 20 amps to 200 amps and deliver 28 volts dc The 200 amp unit, 28VS200Y, weighs under 17 pounds, measures a trim 11 inches, and occupies only 310 cubic inches The other units in this series are proportionately lighter and smaller. All the units work off 200 volt, 3 phase, 400 cycle aircraft power supplies.

Only Chatham's exciting departure from conventional transformer design makes the compact Y-Series possible For the first time a transformer has been designed with a compact symmetrical 'Y' coil configuration. Aside from drastically slicing weight and volume, this remarkable design assures optimum performance by keeping flux linkages uniform while minimizing possible spurious linkages. These characteristics and the quality components engineered into the Y-Series provide for low ripple voltage and produce extremely flat voltage output from no-load to full-load

All the silicon rectifiers and the sturdy cast aluminum heat sinks used in the Y-Series were specifically designed for this application You're sure of getting the highest dependability in the best and most efficient power conversion package. The Y-Series features fan cooling which offers complete mounting flexibility in any attitude Motor operation is guaranteed for 7500 hours at 71° C and for 2000 hours at 125° C A very minimum of 10,000 hours and 2500 hours, respectively, is expected

In addition to the Y-Series TR units, Chatham also makes inverters and other power conversion equipment for missiles and other aircraft industry uses You can get a complete description of Chatham power conversion equipment by writing for brochure T-26. Chatham Electronics, division of Tung-Sol Electric Inc., Livingston, N. J. Sales Offices Culver City, Calif., Dallas, Texas TWX. NK193

CHATHAM ELECTRONICS
division of
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Generally, laminated shims of LAMINUM are custom stamped to blueprint specifications Because the laminations are so easily p-e-e-l-e-d to bring the shims down to desired thickness, LAMINUM shims are used universally on assembly lines where they save time and cut costs.

But occasionally you run into a special situation —the need for a shim of *varying* thickness, for example LAMINUM solves that problem with cost cutting ease. As illustrated, the shim is scored into quarters Then layers are p-e-e-l-e-d from the quarters so as to come up with varying thicknesses to correspond with variations in the job at hand

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LAMINUM is the registered trade name for Laminated Shims with layers completely surface bonded to look and act like solid metal Design Folder No 3 contains all facts and engineering data Send for it

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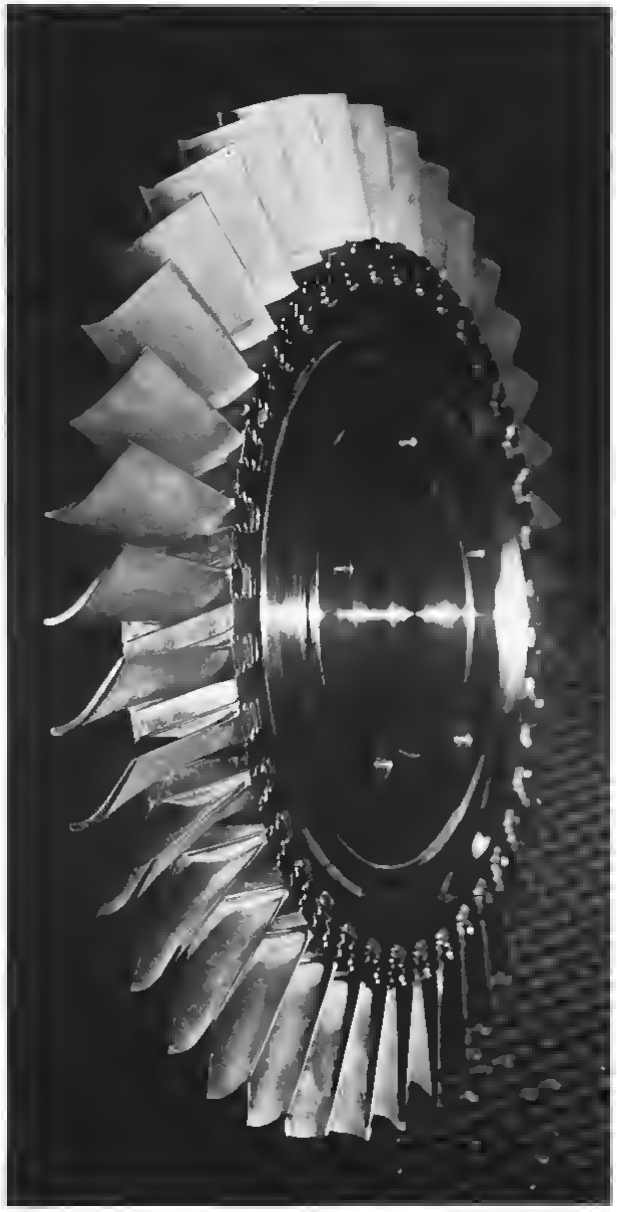

complex jet engine componentry

This complete jet turbine wheel is a product of Kelsey Hayes, Jackson, Michigan plant. Its high standards of performance reflect Kelsey-Hayes' capabilities in the production of crucial rotating machinery, components and assemblies.

As a major subcontractor to the aerospace industries, Kelsey-Hayes' capabilities also include the production of vacuum induction-melted alloys, as well as design, development and production of advanced thrust vectoring devices.
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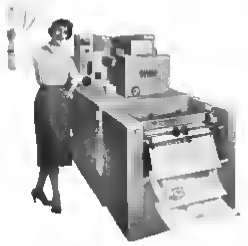

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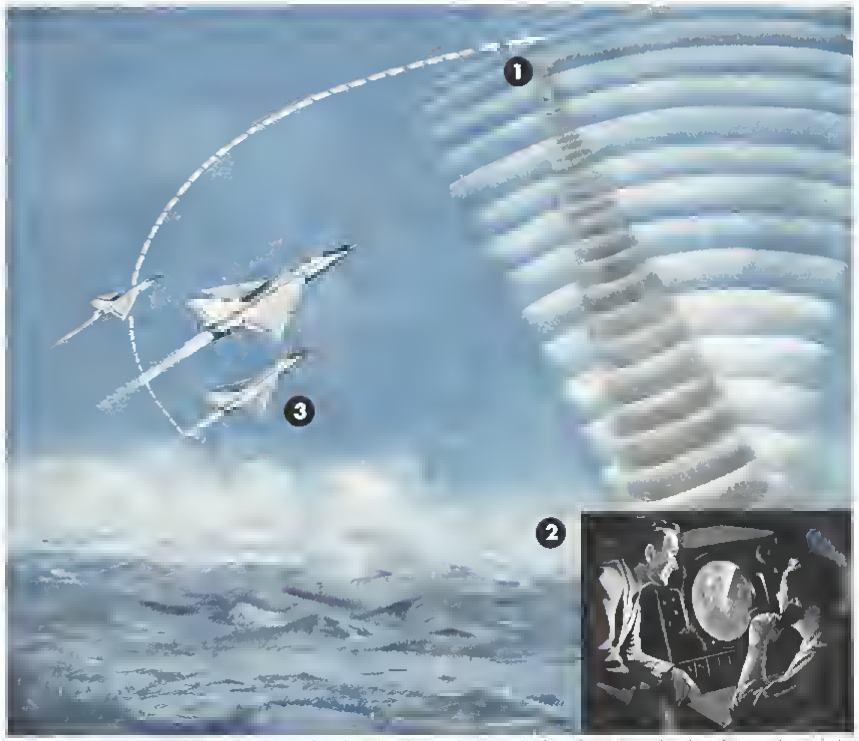
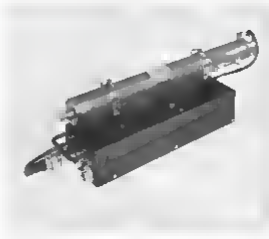


(1) Drone flies at speeds of Mach 2 and beyond and at altitudes greater than 50,000 feet. Pulse from ground radar is detected by drone's SEE system, which "enhances" the pulse and retransmits it (2) to radar station. Much larger "pip" is seen on radarscope than drone would ordinarily make. Size of picture can be adjusted to suit the particular military exercise. Radar operator dispatches fighters or missiles (3) which intercept and "kill" drone.

How drones "stand in" for giant bombers and missiles



KEY COMPONENTS in SEE system are Sperry Traveling Wave Tube Amplifier, and compact power package. Total weight less than 20 pounds.

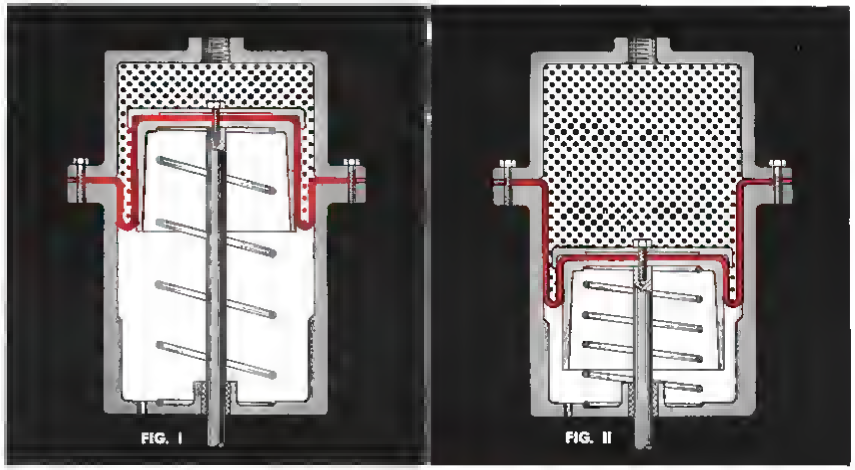
For testing the nation's defenses, a unique electronic system—named SEE for Sperry Echo Enhancer—makes miniature target drones look like intercontinental bombers or missiles.

SEE is a simple and inexpensive method of doing this vital job. Weighing less than 20 pounds, it consists of a traveling wave tube developed by Sperry's Electronic Tube Division, plus a miniaturized power "package" and antennas. By means of simple antennas the equipment receives signals from ground radars, returns these signals with greater intensity to ground radarscopes. "Pips" of any desired size can be created.

Extensively flight-tested at Cape Canaveral, SEE has had broad acceptance by the military services and is being delivered also to defense contractors and friendly foreign governments. Designed for use with either surveillance, air-intercept or tracking radars, it is also applicable to ground control since it can be used in locating and tracking aircraft with great accuracy and over long ranges.

SPERRY

AERONAUTICAL EQUIPMENT DIVISION, *SPERRY GYROSCOPE COMPANY DIVISION OF SPERRY RAND CORPORATION GREAT NECK, N. Y.*



FRICTION ELIMINATED TO ACHIEVE

the Ultimate in Performance

FOR SPRING RESTRAINED ACCELEROMETERS

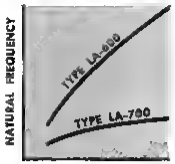
TYPE LA-600
shown actual size

- Full Scale Range ±1 to ±40 G
- Full Scale Output 1o 25 volts
- Threshold-Resolution: 0.0001 G
- Damping Ratio: 0.6 ± 2 typical from −65°F to +250°F
- Natural Frequency: 16 to 100 cps
- Cross-Axis Sensitivity: ≤ 005 G per G maximum
- Shock 1o 60 G
- Vibration 10 G to 2000 cps
- Size: 1⅞" diameter, 2⅜" long
- Weight 1.2 lbs. maximum

TYPE LA-700.
shown actual size

- Full Scale Range ±1 to ±62 G
- Full Scale Output 1o 25 volts
- Threshold-Resolution 0.0001 G
- Damping Ratio 0.6 at 25°C typical
- Natural Frequency: 5 to 30 cps
- Cross-Axis Sensitivity: ≤ 005 G per G maximum
- Shock: 1o 120 G
- Vibration 15 G to 2000 cps
- Size: 2½" diameter, 2⅞" long
- Weight: 1.2 lbs maximum

The virtual elimination of friction in both these new Honeywell linear accelerometers is made possible by a unique web spring suspension. This feature combined with an electro-magnetic pick-off permits resolutions of extremely low level inputs.



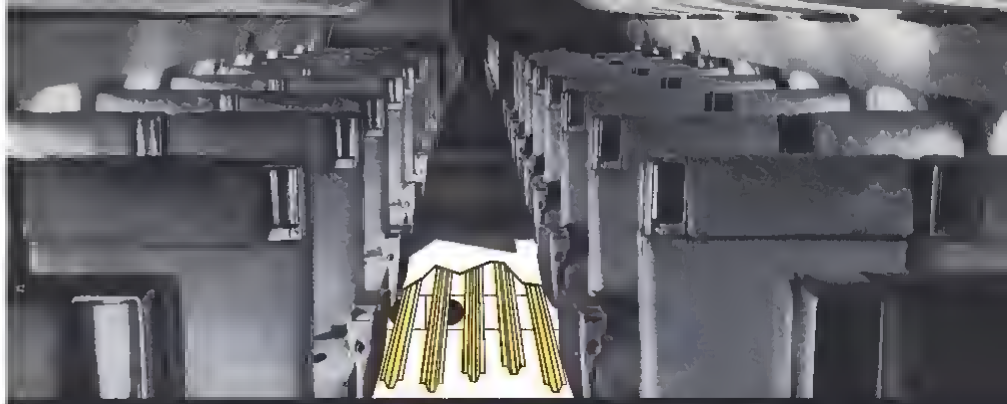
These two instruments span the entire range of dynamic performance.

The LA-600 with its magnetic damping is used for higher natural frequency applications. The LA-700 with its compensated fluid damping is designed for lower natural frequency applications. Write for Bulletins LA-600 and LA-700 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.

75th YEAR — PIONEERING THE FUTURE

Honeywell

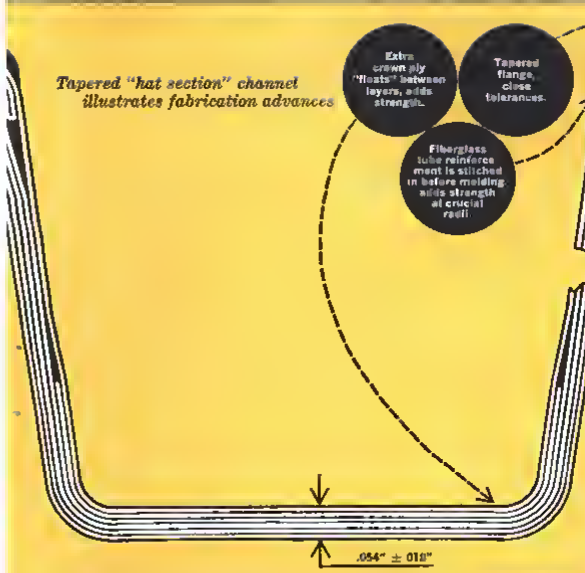
Military Products Group — SINCE 1900



meeting the challenge of

THE STRENGTH/WEIGHT PROBLEM

Tapered "hat section" channel illustrates fabrication advances



DC-8 Floor Channels... Producibility: Swedlow

To provide Douglas DC-8 cabin floors with thermal insulation as well as high strength and minimum weight, Swedlow is producing an unusual type of supporting channel using matched die techniques. Solving the producibility problem called for new methods of fabricating complex laminates. Swedlow's success is seen in this non-uniform cross section "hat" channel which replaces metal sub-flooring. The material is multi-ply fiberglass cloth impregnated with a high temperature epoxy resin system. A difficult tapered flange and extra reinforcement at key points increase strength. Swedlow quality control assures close tolerances and good physical properties up to 300°F. This development of Swedlow skills and materials holds promise in many applications requiring high strength-to-weight ratios, temperature resistance and precise fabrication.

Write for technical bulletin.
Please refer to Dept. 10.

SWEDLOW Inc.
LOS ANGELES 22 CALIFORNIA
YOUNGSTOWN 8 OHIO

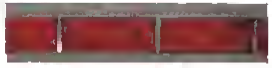
Johns-Manville Announces... MIN-K-LAD INTERLOK

. . . a new structural system interlocking Min-K insulation and high-temperature reinforced plastic

Missile experience shows that in certain heat control situations no one material will perform as well as two (or more)—*an insulation with protective high-temperature facings*

Problem is how to effectively combine these materials into a structurally strong unit? The answer is Min-Klad Interlok

1) Outer facing, 2) interlocking web, 3) Core any one of several Min-K formulations, and 4) Inner facing



All the above components combine to provide a custom made structural strong insulating system

—a new structural system that interlocks Min-K insulation and reinforced plastic, metal or other high-temperature facings

The result: one product that gives the missile designer every advantage of high-temperature plastic or metal foil—strength, toughness, rigidity! Erosion resistance! High heat capacity!

plus the outstanding advantages of Min-K insulation—an insulating core that has the lowest thermal conductivity available for service temperatures up to 2000°F steady-state and higher for transients. Min-K's thermal conductivity is actually lower than the molecular conductivity of still air

Wide range of facings

For the hot face, the missile designer can specify Min-Klad Interlok in a wide variety of heat-resistant and/or ablating materials—asbestos-phenolic (ARP-40), and similar reinforced plastics, as well as stainless steel and other heat-resistant metal foils and meshes. For some requirements, the cool face can be made of a different material—for example, one that offers characteristics required for bonding or fastening to other surfaces and parts.

Like all J-M Aviation insulations, Min-Klad Interlok is factory-fabricated to your specifications into external skin panels, heat shields, cylindrical liners or component housings of any shape or size. Write today for technical specifications. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

TODAY the aerospace industry is squarely confronted with a situation that cannot be soft-pedaled.

Buying fasteners on the basis of price alone can be—and with sickening frequency is—disastrous.

"But it met the specifications" is a feeble excuse in the face of a huge pile of smoldering scrap metal—the result of failure by a supposedly high-strength bolt. Yet the lot which included this bolt actually met specifications.

Still the bolt failed. Why? Was it improper manufacturing? Or weak quality control? Maybe careless testing. Or no testing at all. One thing, however, is certain, dead certain. Specifications alone cannot guarantee high reliability.

Aircraft, missile and rocket projects are far too critical to permit the assumption that a fastener will perform faultlessly simply because it meets the specifications.

Today the complete facilities of every fastener manufacturer must be uncompromisingly appraised, for his methods and equipment are the only assurance of the reliability of his product.

How to judge the reliability of different brand bolts? Take a good hard look at what stands behind each product.

Scrutinize. Probe. Compare.

Above all, note very carefully a supplier's ability to test fasteners. Does each manufacturer have all of the complex and powerful machinery that is absolutely essential to destructive testing of high-strength bolts? What about test results? Is the evidence really conclusive? To produce fasteners that will not fail, a manufacturer must test ceaselessly... ruthlessly.

Many in sensitive positions in the aerospace industry today are so often urged to keep their eye on "the big picture" that they may lose sight of *the small part*. Yet the deceptively simple aircraft bolt is a bothed of surface and internal stresses. And, ironically, though it represents so minute a fraction of the project's cost as to be almost immeasurable, one fastener *can* cause catastrophe.

AIRCRAFT/MISSILE Division

JENKINTOWN 3, PENNSYLVANIA
SPS WESTERN, SANTA ANA, CALIFORNIA

SPS
where reliability replaces probability

PROBLEM:

Measure angular acceleration accurately

ANSWER:

The New Donner Angular Accelerometer

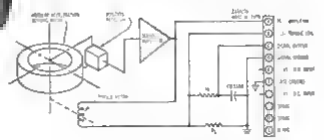
Light

Compact

High natural frequency

THE FACTS... As you are well aware, designing a good angular accelerometer is a tough technical task. Donner Scientific's new unit is another successful chapter in a record of creative engineering.

Chief applications for this unique force balance angular accelerometer are closing the servo loop on ground launching equipment for missiles and detecting the roll, pitch and yaw accelerations of missiles once they are airborne. In the latter application, the Model 4525 can replace some gyros and supplement others.



Operational diagram of Donner's new Model 4525 Angular Accelerometer.

Donner's rugged new angular accelerometer weighs only 2 pounds.

The Specs

RANGES AVAILABLE
From ±1 radian/sec² to ±50 rad/sec² to any intermediate range
FREQUENCY RESPONSES
±1 rad/sec² 30 cps natural frequency (90° lag)
±10 rad/sec² 100 cps natural frequency (90° lag)
OUTPUT, FULL SCALE
±20 volts across a 12,500 ohm load
RESOLUTION 0.01% full scale or better
LINEARITY 0.1% full scale
HYSTERESIS Less than 0.01% full scale
DAMPING 0.6 ± 0.1 of critical
SIZE 3.7" diameter x 3.7" high
WEIGHT 2 pounds

The mechanically rugged and electronically rigid Model 4525 is one more basic technical contribution from an engineering team specializing in inertial systems interlocking time, acceleration, velocity, and other dynamic inputs.

MORE DATA AVAILABLE—An illustrated 4 page data file is yours for the asking. Please address Dept. 05-3. •

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA

Morse engineers look to space from a down-to-earth viewpoint!

Sky is never the limit with the research and development staff working with the broad facilities at Morse.

Morse has grown up with the automotive industry. Its specialists have worked with designers and engineers in developing and perfecting the products of their imagination.

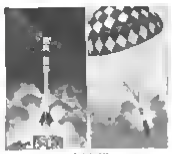
For more than 60 years, Morse has specialized in the science of kinematics. Perhaps its best known products are basic chain drives, gear reducers, couplings, and clutches in more major fields than you could count on the fingers of both hands.

Morse engineers, supported by Borg-Warner's ultra-modern research laboratory, can now offer a better way of giving your ideas a boost, and provide down-to-earth solutions to your problems in the race for space. Consult Morse Chain Company, Dept. 37-30, Borg-Warner Industry, Ithaca, N.Y. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ontario.

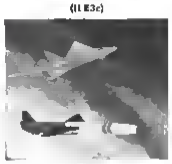
World's largest manufacturer of precision parts

MORSE BW
A BORG-WARNER INDUSTRY

8842 AC



POGO-HI
(II E3c)



P-107
AIR LAUNCHED

P-106
GROUND LAUNCHED

AERONCA TARGET MISSILES PERFORM A VARIETY OF MISSION PROFILES... WITH SUBSTANTIAL ECONOMY

The adage "practice makes perfect" keynotes today's concept of missile warfare. Against supersonic targets, there isn't time for "the second barrel!" Therefore, extensive operational testing of air defence systems . . . and training programs for personnel who operate them . . . must be conducted to assure national preparedness.

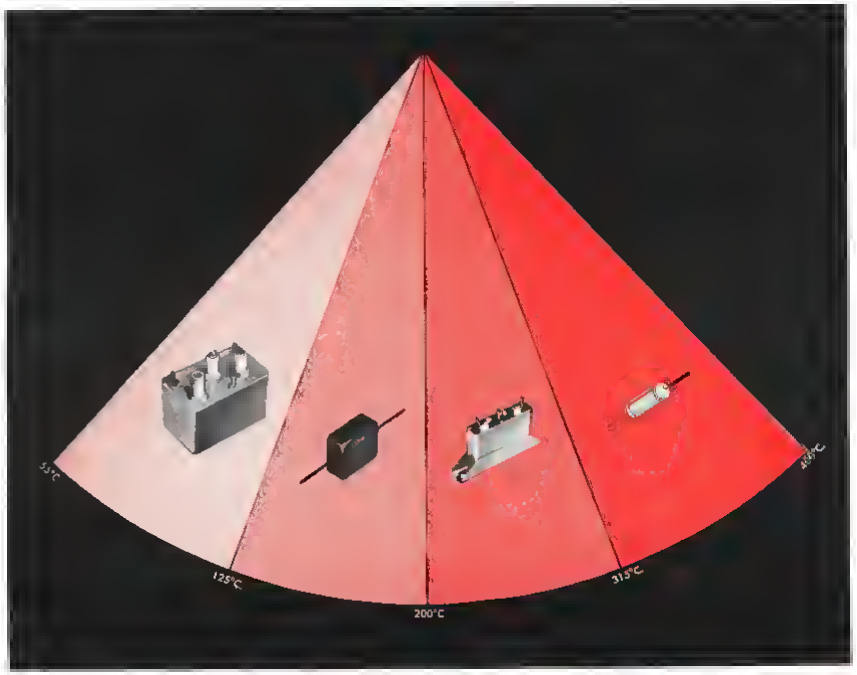
To accomplish this requirement at minimum cost, Aeronca has developed two expendable, lightweight, high performance target systems under the Design Tool Produce envelope concept. These proprietary missile programs, the P-106 and P-107, are designed for supersonic performance and accurate scoring at all required altitudes, speeds and ranges. *And their production cost is projected to be substantially less than any current target missile system!*

Another Aeronca produced missile project is *Pogo-Hi II E3c*. Ground launched to high altitudes, this target utilizes a radar reflective parachute and an infrared emitter package. It is used as "bait" for such current projects as *Nike, Talos, Sidewinder* and *Falcon*.

With integrated Design, Tooling and Production capabilities, Aeronca can produce weapon systems envelopes at either prime or subcontractor levels.

AERONCA manufacturing corporation
1714 GERMANTOWN ROAD • MIDDLETOWN, OHIO

Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.



BENDIX CAPACITORS COVER A FULL TEMPERATURE SPECTRUM

ALL FEATURE THESE IMPORTANT ADVANTAGES:

Environmental resistance **Wide voltage range** **High I. R.** **Radiation resistant**
No voltage derating **Solid impregnants** **Wound mica papers** **Exceptional stability**

Under 125°C.—Specials
• Size and weight reductions at high voltages • Drift—.25% capacitance change typical from −55°C. to +125°C. • High I. R.—1500 megohm X microfarads typical at 125°C. • Solid impregnants—no liquid leakage.

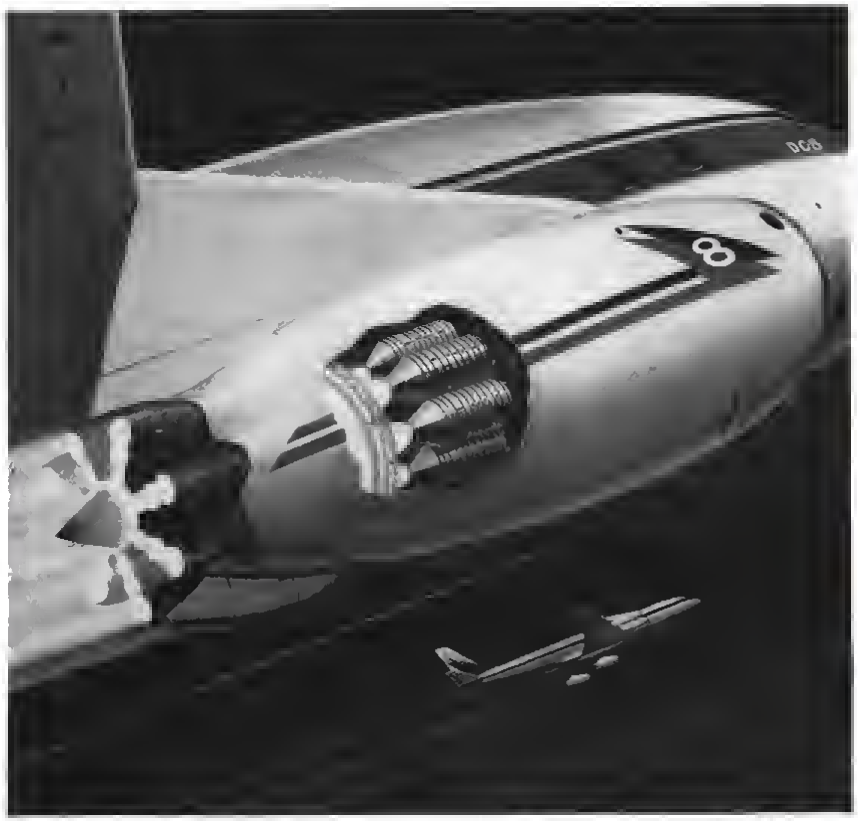
125°C. to 200°C.—Available soon
• .001 to 6.0 mfd., 200 V to 3 KV, specials to 10 KV. • Molded and metal housed, tubular and rectangular. • Size and weight reduction—over plastic film and stacked mica types, particularly at high voltages. • Drift—1% capacitance change typical from −55°C. to +200°C. • High I. R.—50 megohm X microfarads typical at 200°C. • Proved in 4 years' usage.

200°C. to 315°C.—In production
• .05 to 4.0 uf, 600 V and up • Drift—3% capacitance change typical from −55°C. to +315°C. • High I. R.—10 megohm X microfarads typical at 315°C. • Nothing smaller at 315°C.

315°C. to 400°C.—In development
• .001 to 6.0 uf, 150 V and 600 V • Drift—5% capacitance change typical from −55°C. to +426°C. • High I. R.—1 megohm X microfarad typical at 400°C. • Prototype availability • Only inorganic materials used.

For full details, write:
Scintilla Division
Sidney, New York

Bendix AVIATION CORPORATION



Inconel combustion chamber liners provide long service life in the jet engines that speed modern United Airlines DC-8's.

Inconel liners handle the power that speeds United Airlines' new jet fleet

Jet engines that generate power for modern aircraft, generate hot problems in combustion chambers.

Chamber liners go to red heat. The roaring gases produce severely oxidizing conditions.

Inconel* nickel-chromium alloy linings, shown in a DC-8's jet engine above, easily handle the heat, the oxidizing, corrosive attack of hot gases. Retain useful strength, too.

Proof?

Inconel liners in JT-3** jet engines have given nearly 3 *million* hours of dependable performance...under every conceivable operating condition.

Inconel liners also serve dependably in larger JT-4** jet engines, also used in some DC-8's.

On the production line, Inconel alloy pays dividends, too. Ductility enough for complex forming, drawing operations. Good weldability.

Nationwide Availability

Inconel alloy is available in all common mill forms from warehouse stocks across the country.

If you're looking to solve special problems involving heat and corrosion, look to Inconel alloy. Write us for more specific information.

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

*Inco trademark. **JT-3 and JT-4 engines are produced by Pratt & Whitney Aircraft Div. of United Aircraft Corporation, Hartford, Conn.

INCONEL®

Now on Atlas, Titan & Centaur Missiles

LEONARD PILOT OPERATED RELIEF VALVES

with operating temperature range of −320°F to +200°F

These two Pilot Operated Relief Valves, currently in production at Leonard, have zero leakage over a temperature range of −320°F to +200°F, and withstand the extremes of shock and vibration. Featuring a unique pilot operated circuit, the units are small in size, and but 14 ounces in weight. Their reliability and accuracy has gained for them wide recognition as ideal missile components, as well as for many ground and static applications. The two valves shown are typical of the many relief valves that have been produced by Leonard which cover wide ranges of pressures, medias and flow conditions. Note the detailed specifications.

Please visit our Hospitality Suite at the ISA FLIGHT TEST SYMPOSIUM—May 2-5 • Hotel Del Coronado, San Diego, Calif.

SPECIFICATIONS • MODEL #193060

Media	Helium
Cracking Pressure	385 psig max.
Reseat Pressure	370 min.
Flow	.15 lbs/sec
Leakage	55 cc/min @−320°F
Operating Temperature	−320°F to +200°F
Vibration	30 G 10 to 2000 cps
Acceleration	20 G's
Weight	14 oz.
Overall Length	5 40 in.
Response Time	5 ms. to full open

SPECIFICATIONS • MODEL #193200

Media	Helium
Cracking Pressure	32 psig max.
Reseat Pressure	29 min.
Flow	.032 lbs/sec
Leakage	5 cc/min @−320°F
Operating Temperature	−320°F to +200°F
Vibration	MIL E 5272, Proc. I
Acceleration	20 G's
Weight	14 oz.
Overall Length	6 00 in.
Response Time	5 ms. to full open

DESIGN PARAMETERS • MODEL #193060

Maximum Flow	.36 lbs/sec.
Cracking Pressure	250 to 1000 psig.
Media	GOX, Hydrogen Nitrogen, and other gases

DESIGN PARAMETERS • MODEL #193200

Maximum Flow	.2 lbs/sec
Cracking Pressure	30 to 250 psig.
Media	GOX, Hydrogen, Nitrogen, and other gases

The relief valves featured are typical of the more than 200 precision pneumatic and hydraulic pressure control devices which have been developed during the past 10 years at Wallace O. Leonard, Inc., and are now standard equipment on all ICBM's. Leonard product classifications cover: Regulators • Valves • Switches • Flow Restrictors • Primary Pressure Source • Servo Transducers—Flight Test Systems, Pressure Ratio Computers, Lox and Fuel Tank Level Computers • Systems—Tanking Computers, Primary Pressure Standards.

Leonard craftsmen and advanced technical personnel have built an enviable reputation for superior products for missile guidance, control and ground support applications. May we have the pleasure of reviewing your specific requirements in these areas? For consultation and information please write to:

LEONARD PASADENA

Wallace O. Leonard, Inc.

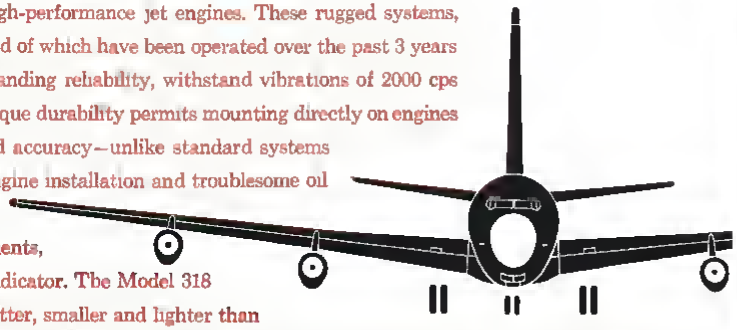
373 South Fair Oaks Avenue • Pasadena, California
Telephone SYcamore 2 7131 • TWX—PASA CAL 7321

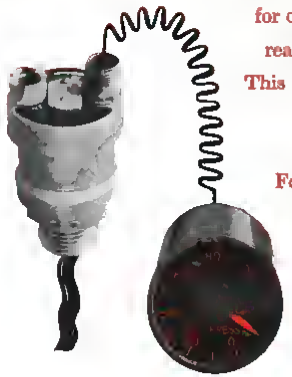
Eastern Sales Representatives: **BRIERLEY, DAVIS COMPANY**
332 Springfield Ave., Summit, N. J. • Telephone CRestview 3-7300 • TWX—SUMMIT NJ 355

Specify Thomas A. **EDISON** for

AVIATION'S MOST RELIABLE PRESSURE INDICATING SYSTEM

Edison's pressure indicating system provides unique protection for today's high-performance jet engines. These rugged systems, several thousand of which have been operated over the past 3 years with outstanding reliability, withstand vibrations of 2000 cps at 20 g's. This unique durability permits mounting directly on engines for greater response, and accuracy—unlike standard systems which require off-engine installation and troublesome oil or fuel lines. The system consists of two components, transmitter and indicator. The Model 318 frictionless transmitter, smaller and lighter than ever before, meets requirements of new specification MIL-T-26638. Hermetically sealed indicators, available in 1½" and 2", require less than 0.6 watts for operation. A 2" model is integrally lighted for utmost readability in compliance with MIL-L-25467A (ASG). This versatile indicating system—originally designed for oil pressure measurement—can also be used to indicate fuel pressure, BMEP, as well as torque. For the full story on aviation's most reliable pressure indicating system, write for publication 3049.





Standard hermetically sealed indicator, available in 1½" and 2". Model 236, a 2" indicator, is integrally lighted. In daylight, numerals and pointer are white and at night red. When power is off, pointer will move off-scale below zero.

Thomas A. Edison Industries
INSTRUMENT DIVISION
49 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

The Matrix of Site Instrumentation

Site instrumentation—from complete electronic installation management to the engineering of customized systems and sub-systems—is a specialty of Western Design. ■ Typical of Western Design's site instrumentation capability is the new data calibration system for the Air Force Minuteman ICBM, designed to certify performance of transducers in the Hercules solid propulsion system. This automatic system, with both permanent and quick-look read out, measures 160 transducers in 10 minutes, incorporates high safety standards and can be operated remotely by unskilled personnel. ■ For reliable, imaginative site instrumentation, check Western Design . . . a company with strong corporate financial back-up and extensive experience in military electronic and electro-mechanical equipment, sub-systems and systems. For further information, write for Data File AW-1029-1.

Western Design
DIVISION OF U S INDUSTRIES, INC
SANTA BARBARA AIRPORT, GOLETA, CALIFORNIA

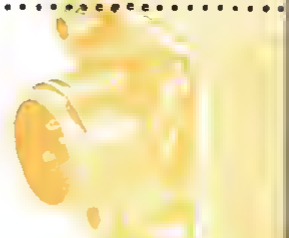
usi

For a proposal you can rely on contact your Janitrol engineering representative when your plans call for components, pneumatic sub-systems, and complete systems for heat transfer and air control. Virtually every modern aircraft and operational missile incorporates the skills that Janitrol translates into practical hardware. Janitrol Aircraft, a division of Midland-Ross Corporation, 4200 Surface Road, Columbus 4, Ohio

JANITROL

reliable components for missiles / aircraft / support

general characteristics



Maximum rated flow	valve pressure drop 1000 psi	3000 psi
Series 31	4 gpm	7 gpm
Series 32	8 gpm	14 gpm
Operating supply pressure	50 psi to 4000 psi	
Electrical signal power	40 milliwatts minimum	
Temperature range (fluid and ambient)	—65°F to 350°F standard to 450°F or 600°F on special order	
Resolution	<½ %	
Hysteresis	<3%	
Null shift		
temperature —65°F to 450°F	<4 %	
acceleration to 90g	<5%	
supply pressure 80% to 100%	<2%	
quiescent current 50% to 200% rated current	<2%	
back pressure 0% to 20% of supply	<2%	
Weight (approximate)	0.75 pounds	

series 31 and 32

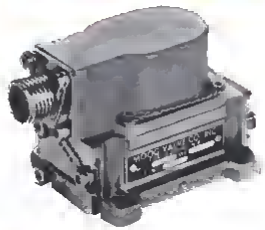
flow control

servovalves

with mechanical feedback

from

MOOG

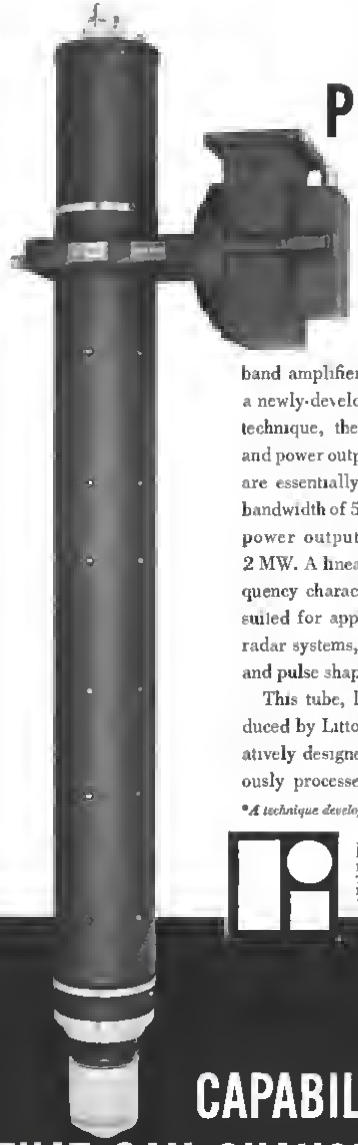


Series 31 and 32 servovalves are miniaturized two stage flow control valves which utilize internal mechanical feedback. Features of the new design include high performance, simplification and compactness, together with a wide temperature capability. Specific valve characteristics can be achieved other than the ones listed above.

Write for catalog 310 and individual model data sheets that illustrate typical performance variations.

MOOG SERVOCONTROLS, INC. PRONER AIRPORT, EAST AURORA, N. Y.

LEADING INNOVATOR AND PRODUCER OF ADVANCED ELECTROHYDRAULIC SERVOVALVES



L-BAND KLYSTRON PROVIDES BROADBAND PERFORMANCE

This addition to Litton Industries' Klystron family introduces a new concept in broadband amplifier tubes. Through use of a newly-developed Skirtron* bunching technique, the L-3283 achieves gain and power output characteristics, which are essentially flat over the minimum bandwidth of 50 Mc. Its minimum peak power output at the band edges is 2 MW. A linear phase shift versus frequency characteristic makes it ideally suited for application in sophisticated radar systems, where electronic tuning and pulse shaping are required.

This tube, like all other tubes produced by Litton Industries, is conservatively designed and rated; and rigorously processed to provide thousands of hours of reliable operation. Typical of the performance obtained from applying this design philosophy is that of the L-3035, a 2.2 MW L-band Klystron, whose *average* operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide top performance after operating for more than 10,000 hours.

The Skirtron technique is being applied to other tubes now being developed to obtain even broader-band performance at higher power levels and in other frequency ranges. Should you require high power broadband performance for your current (L-3283 is available now) or future system planning, write to Litton Industries, Electron Tube Division, Office A 12, 960 Industrial Road, San Carlos, California.

**A technique developed by Litton Industries which provides improved broadband performance.*

LITTON INDUSTRIES Electron Tube Division

BARRATRON TRANSMITTING TUBES • MAGNETRONS • KLYSTRONS • TRAVELING WAVE TUBES • BACKWARD WAVE OSCILLATORS • CARCINOTRONS • GAS DISCHARGE TUBES NOISE SOURCES • CROSSED FIELD AMPLIFIERS • HIGH DEFINITION CRT • DIRECT WRITING CRT • COLOR CRT • STORAGE TUBES • MICROWAVE FILTERS • DUPLEXERS • TR TUBES

CAPABILITY THAT CAN CHANGE YOUR PLANNING

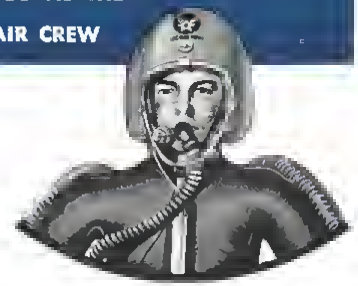
SCOTT RESEARCH AND DEVELOPMENT PROVIDES THE MAN IN FLIGHT WITH THE MOST ADVANCED SYSTEMS OF PROTECTION AND SURVIVAL!

Environmental protection of the air crew is the important link between theoretical aircraft performance and actual flight records.

For more than ten years, Scott has designed and produced more portable oxygen equipment than any other manufacturer in the world. *Now*, Scott also leads in the design and production of high-altitude oxygen breathing equipment for protection during flight or ejection.

Scott High Altitude Protective Equipment has been designed, developed and produced in cooperation with personnel of cognizant Departments of Defense and prime contractors. The knowledge and experience of these scientists and engineers have been combined with our own efforts to make the U.S. Crewman the best protected in the world!

Dedicated imaginative Engineers can find full expression for their talents at Scott Aviation Corp. Write in confidence to Walter H. Winter, Personnel Director



In Flight or Ejected His Life is *Scott* Protected

The Scott Building Block Design Concept integrates components block to block, to produce a completely interchangeable, modular oxygen assembly that can be quickly removed, serviced and replaced without disturbing any other portion of the aircraft.

SINCE 1932

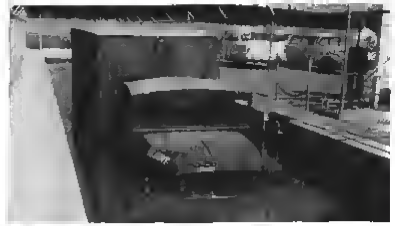
AVIATION CORPORATION

275 ERIE STREET • LANCASTER, NEW YORK

Export: Southern Oxygen Co., 250 West 57th Street, New York 19, N.Y. • West Coast Office: Fulton-Ventura Building, 13273 Ventura Boulevard, Studio City, California

How to thread a needle in the dark

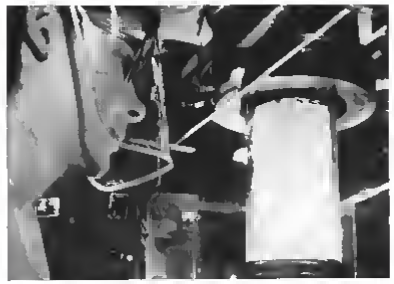
The Fording Test *is typical of the tough environmental tests imposed upon advanced electronic equipment designed and produced by Hughes Fullerton engineers.*



TARAN (Tactical Attack Radar and Navigator) is typical of the important new electronic systems developed by Hughes—in an atmosphere famed for its engineering orientation.

Hughes engineers have designed this system to enable pilots to fly blind at very low altitudes in any kind of weather—and actually deliver any kind of armament at tactical targets.

TARAN's amazing abilities are based on several major electronic advances developed by Hughes engineers: A radar system with several times the range and azimuth resolution of current radars. An Automatic Navigation and Display System which pinpoints position continuously and automatically corrects for any navigational deviations. A unique terrain clearance indication warns the pilot of any obstacles when flying at low altitudes. A radar antenna utilizing electronic rather than mechanical lobing.



Molten Ladle *of silicon is watched during first step in the precise manufacture of Hughes semiconductors, just one of the Hughes commercial activities.*

Other Hughes activities provide similarly stimulating outlets for creative engineers. A few representative project areas include: advanced data processing systems, molecular electronics, advanced 3-D surface radar systems, space vehicles, nuclear electronics, ballistic missiles, infrared devices—and a great many others. The commercial activities of Hughes have many interesting assignments open for imaginative engineers to perform research, development, manufacturing of semiconductors, electron tubes, and microwave tubes.

Whatever your field of interest, you'll find Hughes' diversity of advanced projects gives you widest possible latitude for professional and personal growth.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas.

Electroluminescence	Equipment Engineering
Infra-red	Microwave & Storage Tubes
Solid State Physics	Communications Systems
Digital Computers	Inertial Guidance
Reliability & Quality Assurance	Field Engineering
Systems Design & Analysis	Circuit Design & Evaluation

Write in confidence to Mr. R. A. Martin, Hughes General Offices Bldg. 6-A8 Culver City, Calif.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California, Tucson, Arizona

Designed for use in interceptor missiles...

RCA-7553

Rugged New Ceramic-Metal Pencil Tube

Ten-second cathode warm-up and extremely rugged construction make this small triode a significant contribution to missile technology

RCA's ceramic-metal pencil tubes represent the most exciting recent advance in UHF tube design. Tiny and tough—half the length of an ordinary cigarette—they are designed to operate at altitudes as high as 100 000 feet without pressurization ... and at plate-seal temperatures up to 225°C.

RCA-7553—latest addition to this sturdy tube line—was developed specifically for use in missile applications. It offers exceptional resistance to vibration and severe shock, fast warm-up time, and high reliability.

If you are designing miniaturized UHF equipment for operation at frequencies up to 3000 Mc and above, consider using RCA's ceramic-metal pencil tube family. When low heater power, fast warm-up and high thermal stability are essential, these versatile tubes are your obvious answer.

Get in touch with your RCA Field Representative now for complete information on ceramic-metal pencil tubes, including the new developmental type A-15208. This ruggedized S-band integral-cavity tunable oscillator can withstand 10 000 g's of acceleration in missile and rocket beacon applications.

Check these outstanding Ceramic-Metal Pencil Tube Features!

- Large cathode area—about three times more cathode area for the same heater power than comparable planar types
- Fast warm-up time—⅓ the warm-up time of comparable planar types—12 seconds to reach 90% of operating dc plate current (only 10 seconds for RCA 7553)
- Thermal stability—output and noise factor remain essentially constant over ±10% heater voltage fluctuations
- Small size—maximum length 1⅝"; maximum diameter (at grid flange) 9/16"; weighs only 0.3 oz.
- Less affected by nuclear radiation—evidence to date shows that ceramic-metal construction has greater endurance to nuclear radiation than glass-metal constructions
- Cantilever arrangement of coaxial elements provides low interelement leakage, permits good efficiency, and resists shock and vibration

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RCA TUBES ARE ALSO AVAILABLE FROM YOUR AUTHORIZED RCA INDUSTRIAL TUBE DISTRIBUTOR

ANOTHER WAY RCA SERVES INDUSTRY THROUGH ELECTRONICS

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. J.*

Visit the RCA Booths at the New York State IBE SHOW—Booths #1602-8, 1701-7.

ALUMINUM IN THE AGE OF CHALLENGE

TODAY, U.S. MILITARY PLANNERS FACE THE GREATEST CHALLENGE IN THE HISTORY OF OUR NATION: THE BUILDING OF A MODERN, EFFICIENT FIGHTING FORCE CAPABLE OF STRIKING ANYWHERE IN THE WORLD AT A MOMENT'S NOTICE. ★ MOBILITY IS THE KEY TO MODERN MILITARY PLANNING. AT THE HEART OF MOBILITY LIE TWO SIMPLE PHYSICAL FACTS: (1) THE LIGHTER THE LOAD, THE FASTER AND FARTHER IT TRAVELS, AND (2) THE FEWER OBJECTS TO BE MOVED, THE LESS TIME, TRANSPORT AND FUEL IT TAKES TO MOVE THEM. ★ ALUMINUM HOLDS THE KEY TO MOBILITY. ★ REALIZING THE STRATEGIC IMPORTANCE OF ALUMINUM IN CURRENT MILITARY PLANNING, KAISER ALUMINUM HAS ESTABLISHED A SPECIAL DEFENSE INDUSTRY SALES DEPARTMENT WITHIN ITS NATIONWIDE ORGANIZATION OF 40 SALES OFFICES TO OFFER BOTH SALES AND TECHNICAL AID FOR EVERY ASPECT OF MILITARY PROCUREMENT AND PRODUCTION. TO RENDER THIS SERVICE, THE DEFENSE INDUSTRY SALES DEPARTMENT HAS AT ITS COMMAND THE VAST RESOURCES AND FACILITIES OF KAISER ALUMINUM

PLEASE TURN PAGE

HOW KAISER ALUMINUM HELPS YOU OF MILITARY PROCUREMENT

NATIONWIDE PRODUCTION FACILITIES Kaiser Aluminum's plant system includes 25 facilities throughout the nation and abroad.

These facilities offer a completely integrated operation from the mining of bauxite in Jamaica to the final production of finished mill products such as sheet, plate, forgings, extrusions, and many others. Here are some important facts you should know about these facilities.

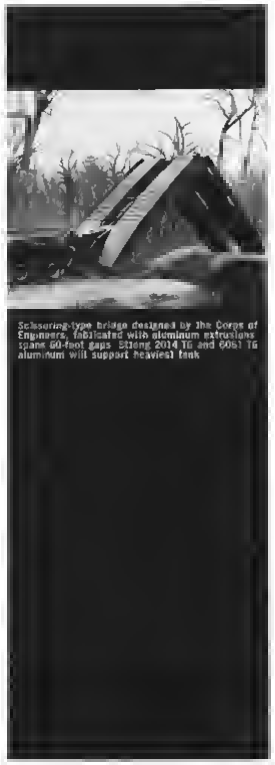
RAVENSWOOD – HOME OF THE 30 MILLION-POUND STRETCHER. At Ravenswood, W. Va., Kaiser Aluminum has recently completed the most modern integrated sheet and plate mill in the world.

One of the newest additions to this plant is a giant aluminum plate stretcher with the industry's greatest pull capacity—*30-million pounds!* The huge stretcher can handle plate 144" wide x 6" thick and 60' long, and opens up new opportunities in the fields of ordnance, cryogenics, naval ships, missiles and aircraft. Along with the 10-million lb. stretcher at Kaiser Aluminum's Trentwood, Washington, plant, the new stretcher makes possible the widest range of stretcher leveled and stress-relieved sheet and plate in the industry.

Vacuum insulated 13,500 gallon air transportable liquid oxygen tank built of Kaiser Aluminum plate by the Standard Steel Corp., Camaridge Div., Lowell, Massachusetts.

THE INDUSTRY'S ONLY MATCHED HEAVY EXTRUSION PRESSES. At Halethorpe, Maryland, Kaiser Aluminum has two modern plants that together provide a completely equipped, fully integrated extrusion manufacturing operation.

Here are located the only matched heavy extrusion presses in the industry – two 8,000-ton presses. This duplication safeguards production by having tools completely interchangeable from one press to another in case one press breaks down. Also, these matched presses can produce unusual extrusions formerly considered impossible.



Scissoring-type bridge designed by the Corps of Engineers, fabricated with aluminum extrusions spans 60-foot gaps. Strong 2014-T6 and 6061-T6 aluminum will support heaviest tank.

COMPLETE FORGING FACILITIES. With 31 pieces of heavy forging equipment—ranging from 1500 to 25,000 pound hammers and 750 to 8,000-ton presses—Kaiser Aluminum's Erie, Pa., plant offers one of the most complete forging facilities in the nation.

Aluminum forgings offer a high strength weight ratio and excellent fatigue strength. They support extreme loads under rugged dynamic loading conditions yet their light weight allows maximum mobility. Precision aluminum forgings hold close tolerances which reduce machining costs and makes aluminum competitive with traditional low cost cast iron and steel forgings.

RESEARCH AND DEVELOPMENT. Kaiser Aluminum's Department of Metallurgical Research, Product Development Department, and other specialized technical staffs conduct continuous research resulting in new alloys and applications of particular value to the Defense industry.

Forged aluminum tank treads, produced at Erie, under contract with U.S. Army Ordnance Tank Automotive Command, Detroit, Mich., were successfully tested at Aberdeen — save 1,000 pounds per vehicle compared to steel.

MEET THE SPECIAL REQUIREMENTS AND MANUFACTURE

NEW HIGH STRENGTH WELDABLE ALLOYS. A major recent advance has been the development and introduction of new, weldable high strength aluminum alloys by Kaiser Aluminum. The two new alloys, 5083 and 5086, provide maximum utility, joint strength and efficiency in welded structures, particularly those subject to impact or dynamic loading. These new alloys are now available in sheet, plate, forgings and extruded forms. The alloys used with new welding techniques, have shown substantial design advantages over weldable aluminum alloys previously available. They also offer good forming properties, outstanding welding characteristics, excellent resistance to corrosion, and improved weld zone ductility.

The LARC-5, developed by the U.S. Army and the Berg Warner Corp., is constructed of high strength, weldable Kaiser Aluminum alloys 5083 and 5086.

THE ONLY BALLISTIC FIRING RANGE IN THE INDUSTRY. As part of its extensive aluminum armor research program, Kaiser Aluminum has undertaken a program for testing armor plate by establishing a firing range for ballistic testing—the first such facility in the aluminum industry. Located at Spokane, Washington, the ballistic firing range conducts extensive tests on aluminum plate, extrusions, and forgings.

TECHNICAL AND MARKETING SERVICE. Kaiser Aluminum's field engineers, technical experts and Defense Industry specialists are at your service through any Kaiser Aluminum sales office. Also, Kaiser Aluminum offers complete marketing assistance to help you expand present markets and develop new ones. Why not take advantage of these services now? Whether you need product information or technical assistance, a phone call or letter will receive our immediate attention. Contact *Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Drive, Oakland 12, California.*

M-113 aluminum armored personnel carrier achieves light weight for air transportability through use of Kaiser Aluminum alloy 5083 plate in hull section. Designed and built by Food Machinery & Chemical Corp.

FREE PORTFOLIO! "*Aluminum In The Defense Industry*" is a file folder packed with information on the many uses of aluminum for military applications. It includes information about the characteristics and properties of aluminum, important findings regarding alloys 5083 and 5086 as used in missiles, ground support equipment, cryogenics and other military applications, plus booklets on Kaiser Aluminum mill products, availabilities and designing with aluminum. For your free portfolio, full of facts you can use – mail the coupon now!

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OAKLAND 12, CALIFORNIA

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KAISER ALUMINUM*
THE BRIGHT STAR OF METALS

Circle Number 45 on Reader-Service Card

Flames swept across the open plains as the Mongol hordes ran in terror from the "arrows of flying fire." When the smoke had cleared the Chinese had won the battle of Pienking with the first rocket.

Missiles have become greatly more sophisticated since this crude unguided arrow was propelled by gunpowder packed in an open-ended bamboo tube. Today, as a vital part of one of the world's largest electronics companies, Raytheon's Missile Systems Division is making significant contributions to the art of missilry. The exciting new Pin Cushion Project for selective missile identification, the constantly advancing Navy's air-to-air SPARROW III and Army's HAWK are examples of their outstanding creative work.

We are seeking highly creative people to maintain Raytheon's leadership in this challenging field. For these people, Raytheon's Missile Systems Division creates a climate for talent — perhaps *your* talent.

MISSILE: 13th CENTURY

ENGINEERS: immediate openings in Data Handling — Circuit Design — Packaging — Electro-Mechanical Design — Systems Test — Test Equipment Design — Systems Analysis — High Power Radar Design — Microwave Tube Application — High Voltage Power Supply — Modulators — Microwave Design — Systems Design — VHF Circuit Design — Operations Analysis — Radar Systems and Mathematicians

Please apply to Mr. W. F. O'Melia, Employment Manager, Bedford Laboratory, Missile Systems Division, Raytheon Company, Bedford, Massachusetts.

RAYTHEON MISSILE SYSTEMS DIVISION

... creates a climate for talent.

Disastrous mid-air collisions and harrowing "near misses" between aircraft in the nation's crowded skies may one day be rare. Federal Aviation Agency and Congress are rushing a whole new system of air-traffic control which will eventually put nearly all military and civilian planes in good weather or bad under control of ground centers using radar, computers and other devices.

White Superior 40-SX-8 diesels have already been purchased for many of these control stations. These dependable 600 KW generator sets will supply automatic standby power, ready to prove in an instant their reputation for quick, easy starting and continuous, reliable operation. Ready to demonstrate, too, that precision construction provides long, trouble-free performance with low maintenance and maximum fuel economy.

White Diesel

You'll find more and more Superiors on applications where human life or the nation's safety are at stake! They have been specified for sections of SAGE (Semi-Automatic Ground Environment), DEW" line (Distant Early Warning), "Texas Towers" (Early Warning Radar Stations) and at various launching stations for U. S. missiles. White can custom-engineer engines to meet your exact requirements . . . offers experience with automatic, unattended and remotely controlled operations. If your requirements range from 215 to 2150 HP, or 150 to 1500 KW, get complete information now!

Superior ATLAS DIESEL ENGINES White DIESEL

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY, *Plant and General Offices: Springfield, Ohio*

RESEARCH AT RYAN has produced a unique, new "strip-winding" technique for making lightweight cylinders of very high strength. Ryan now uses this process, called Ryan Wrap, to build rocket chambers for the Navy's submarine-launched Polaris missile. Thin strips of steel are wound around a mandrel and electrically welded into solid form.

RYAN BLASTS tough space-age metals into complex shapes with high explosives. With a few cents worth of explosives, Ryan achieves forming pressures of over one million psi, to form tough alloys with precision, which could not be formed by any other methods. This has given Ryan a unique, new capability in meeting difficult fabrication problems.

Ryan research finds new ways to get off the ground

Ryan is the pioneer and leader in vertical jet flight—the shortest and quickest way into the sky—with more than three million man-hours of research, design, and engineering experience with VTOL aircraft.

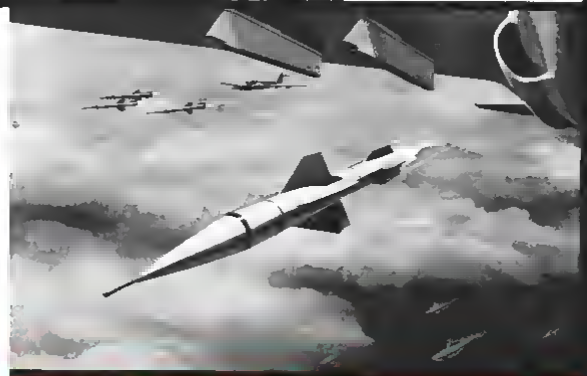
The world's first pure jet VTOL aircraft, the Ryan X-13 Vertijet, set a milestone in flight technology when it made its spectacular demonstration flights at Edwards AFB, and Washington, D. C. It was designed, developed, and built by Ryan four years ago for the United States Air Force.

Advanced knowledge has also been gained in the VTOL/STOL field with the Army VZ3RY aircraft, a turboprop-driven research plane which Ryan designed and now has under test for the Army and the Office of Naval Research. It employs the deflected slipstream principle.

Now Ryan is underway on a new Air Force study contract for an even more advanced VTOL concept. It is the Vertifan which provides, in a single propulsion system, thrust for both vertical and high-performance horizontal flight.

In the electronics field, Ryan is a recognized world leader in continuous wave doppler navigation systems. Ryan developed the first successful C-W doppler navigator—the most effective new method of aerial navigation for both high and low speed flight. Today Ryan navigators guide all types of aircraft, from helicopters and slow flying reconnaissance aircraft to high altitude supersonic jets.

Ryan's bold research plans in VTOL aircraft and navigation systems have blazed a trail toward a new generation of military and commercial aircraft with increased capabilities.



THE SPECIAL SKILLS, advanced scientific know-how, and integrated facilities needed to build many types of missiles and rockets, or their components, are under one roof at Ryan. Ryan's missile capabilities stem from the fabrication of missile propulsion systems; the development of advanced navigation and guidance systems based on continuous wave doppler radar; and the design and production of over 1300 Firebee target missiles—America's most widely used jet target.

Ryan offers challenging opportunities to engineers

RYAN BUILDS BETTER

AIRCRAFT • MISSILES & COMPONENTS • ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

Sharpen a missile's sense of direction?

We've a good mind to do it at ALLISON

DIVISION OF GENERAL MOTORS INDIANAPOLIS, INDIANA

Applicable to many missile and space vehicles—yet providing unusual control and performance advantages . . .

Able to control velocities and direction to establish a precision orbit, impact the moon or destroy a target . . .

Small, light, compact and reliable

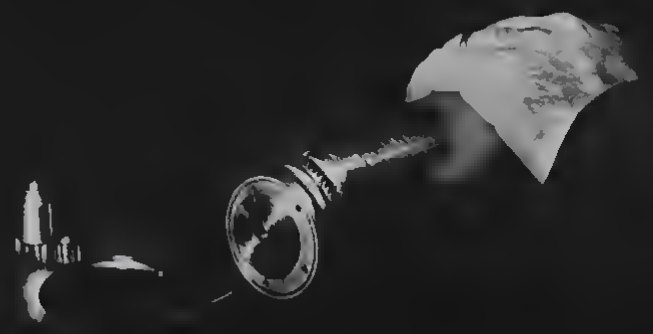
These are some of the parameters of the attitude control systems which are under development at Allison.

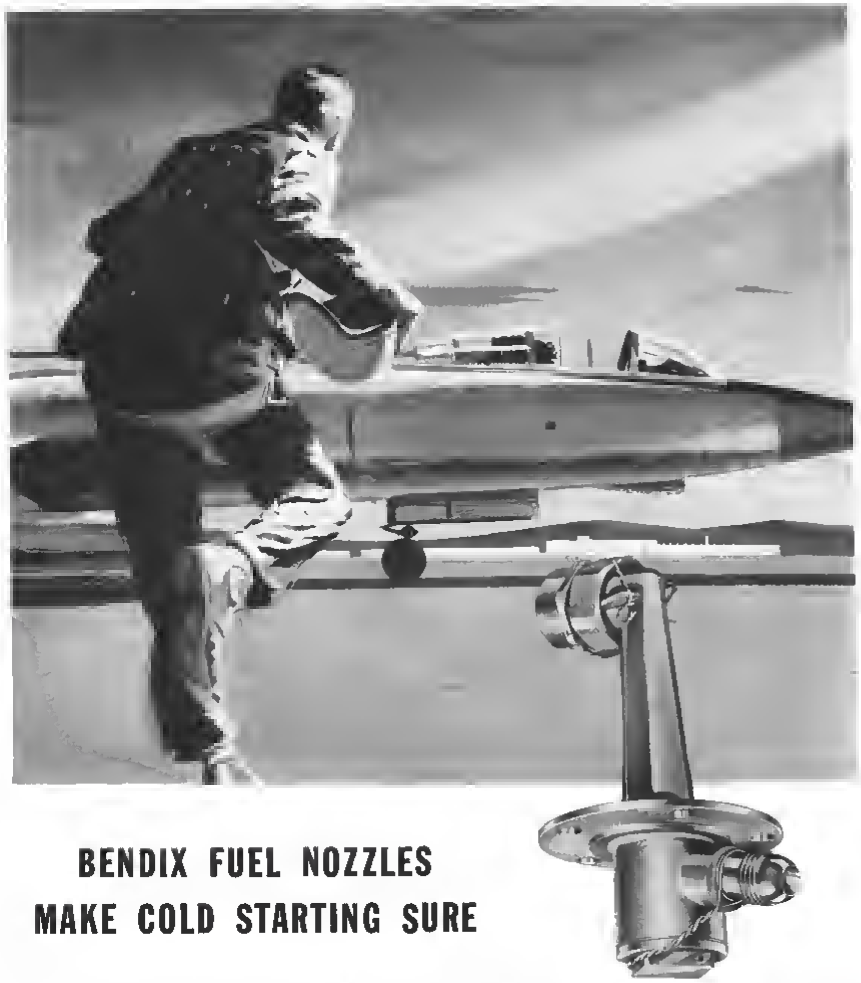
Containing rocket motors, gyros, controls and power supply, they can accurately control small and large vehicles . . . provide mid-course guidance, re-entry control, terminal control . . . can be used on ballistic missiles, anti-missile missiles, manned space vehicles, tactical weapons

And this is but one of the many space-age projects we're putting our minds to at Allison. It's a project which has grown out of the new look at Allison—a project backed by General Motors Research Staff plus every other resource GM possesses.

Whether your problem is concerned with the heavens, the earth, or the oceans, Allison has the will and—if it can be solved—the way to solve it. We're doing it for others, we could do it for you

Illustrated is one of the smaller attitude control systems being developed by Allison for missiles and space vehicles.





BENDIX FUEL NOZZLES MAKE COLD STARTING SURE

When pilots "scramble", there's no time to fool with cold start problems. That's why Bendix Fuel Nozzles are being specified on more and more jet engines—missiles and helicopters, too. Besides overcoming the cold start problem on the ground, these nozzles overcome in-flight starting difficulties after flameouts occur.

Bendix Fuel Nozzles are mass-produced out of long experience to give greater economy and dependable performance through advanced design and manufacturing processes. Today, they are used on engines powering aircraft all the way from the T-37A to the B-47.

Write for details on how Bendix Fuel Nozzles can solve your specific problem.

Bendix-Elmira
Eclipse Machine Division
Elmira, N. Y.

Bendix
AVIATION CORPORATION

Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

in this zone, stainless steels that remain ductile with high strength and stability

In the search for favorable strength-to-weight ratio, high temperature alloys have been developed with extreme strength up to 1000 F, but at the expense of ductility.

In AM 350 and AM 355, Allegheny Ludlum's precipitation hardening stainless steels, you have high hardness and stability from room temperature to 1000 F, plus almost twice the ductility!

These advantages are followed by easy formability using normal techniques. AM 350 and AM 355 can be brazed and welded as easily as the common stainless steels. They can be spun, formed and machined without special preparation.

AM 350 is available commercially in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Penna.**

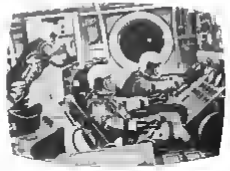
861

ALLEGHENY LUDLUM

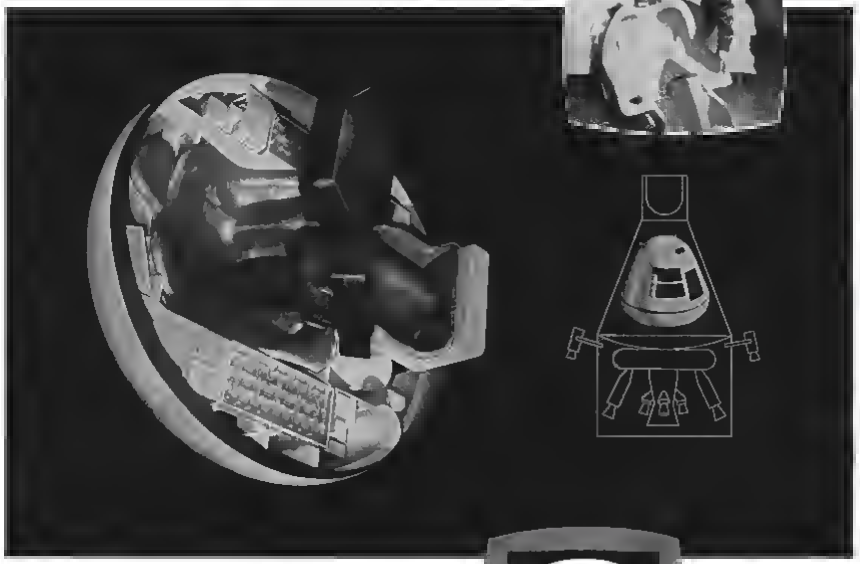
AL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

Space for Stafoam today!



A few months ago we published an advertisement featuring the illustration above, predicting the many uses for *Stafoam* urethane products in manned space ships of the future...



Actual photograph of prototype manned capsule, a major element of maneuverable satellite for rendezvous in space, under development by the Astro Systems Research Laboratories, Norair, Division of Northrop Corp.

Today, a prototype man-carrying space capsule *is* using *Stafoam* cushioning to provide shock endurance and comfort for its human cargo. *Today*, men and intricate devices are insulated against new temperature dimensions with rigid *Stafoam*. *Today*, delicate instruments and components are potted in *Stafoam Polypot*. *Today*, precise mechanical parts are cast with *Stafoam Daycollan*.

Today practical applications for *Stafoam* urethanes are as infinite as space itself. The successful projects listed below have proven to men of vision that there *is* "space for *Stafoam* today."

For a new dimension in material technology, contact the Freedlander R & D Laboratories, American Latex Products Corp., or its branches. Specify product requirements and/or material category.

stafoam
by

AMERICAN LATEX PRODUCTS CORP.

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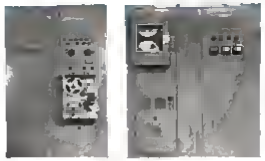
A DIVISION OF THE DAYTON RUBBER CO.
Headquarters for New Ideas

STAFOAM RIGID	STAFOAM FLEXIBLE	POLYRUBBER	POLYPOT	DAYCOLLAN
Thermal insulation	Aircraft & conveyance sealing	Personnel shock padding	Instrument potting	Gear, roller bearings, O rings
Acoustic dampening	Commercial cushioning	Instrument & motor mounts	Crystal clear windows & mtrls	Instrument & control knobs
Foam core construction	Shock padding (high hysteresis)	Elastomer sealing	Control knobs & accessories	Instrument scope hoods
Helmets and liners	Clothing insulation & liners	Oxygen hose and masks	Electronic encasing	Airless wheels & tires
Packaging & flotation	Air & liquid filtering	Window and hatch gasketing	Applicable hardware	Applicable hardware

. . . but Space Age defenses require the speed and reliability of electronic data handling, a proved capability of Cubic Corporation instrumentation at the major missile test centers of the nation.

DH-3 Cubic SECOR, designated the AN/FRQ-10 by the Air Force, is a multi-station missile-tracking system installed on the Eglin Gulf Test Range. The precision distance measurements made by SECOR are digitally coded and magnetically recorded in the Cubic DH-3.



DH-4 To facilitate subsequent computer processing, the DH-4 data is coded in binary form. The DH-4 data playback translator converts the binary data to decimal form, provides an illuminated display and prints out decimal data on paper tape or punched cards.

DH-8 Cubic COTAR is an omnidirectional angle-measuring system which generates a pair of direction cosines. On Ascension Island, a COTAR is combined with Cubic distance-measuring equipment to provide complete position information. The DH-8 performs the necessary analog computation to convert this information to x-y-z form.

DH-10 On the Pacific Missile Range, data is fed from a number of outlying radars to a central computing facility for processing. At each radar, a Cubic DH-10 interrogates the radar and prepares appropriate digital words for transmission and magnetic recording.

DH-14 The Cubic DH-14 Digital Multiplexing Synchronizer is used at a Pacific Missile Range central data-processing facility. It is fed the outputs of one to six DH-10/data-link combinations and multiplexes them, in real time, into a large-scale computer. DH-14 ouput: 36 bits in parallel.

DATA HANDLING

another achievement in Space Age electronics by

CUBIC CORPORATION

5575 Kearny Villa Road, San Diego 11, Calif.

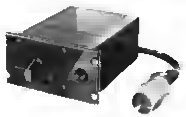
Electronic Engineering with a Dimension for the Future

THE MARK OF QUALITY

BARBER COLMAN

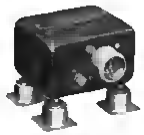
AIRCRAFT AND MISSILE ACCESSORIES

Custom-designed or standard types for wide range of applications



Temperature Controls

Cycling — proportioning — floating, electronic . . . transistor . . . polarized relay . . . and magnetic amplifier types for military, commercial, and business aircraft. Barber-Colman is also the exclusive producer of CEDAC cooling effect detection and control systems.

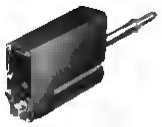


Positioning Controls

Integrated, highly sensitive remote positioning systems designed to your specifications. Magnetic amplifier, electric, and electronic types Anti-hunt feature provided by unique circuitry.

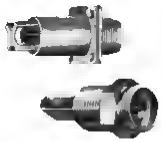
Air Valves

Electrically and pneumatically operated for temperature and pressure-control applications. Butterfly . . . check . . . poppet . . . and automatic drain types. Metallurgically proved materials and precision machining assure long, trouble-free operation. Inquiries invited for missile applications.



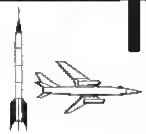
Electromechanical Actuators

Rotary and linear types featuring a wide range of gear reductions, switching, mounting details. The complete Barber-Colman line includes new lightweight, compact actuators for extra space-saving, weightsaving advantages.



Transducers and Thermostats

Units for sensing compartment, duct, and windshield temperatures CEDAC detectors for sensing temperature and/or airflow.



For expert assistance on your control projects, consult the Barber-Colman engineering sales office nearest you: Baltimore, Boston, Fort Worth, Los Angeles, Montreal, New York, Rockford, Seattle.

BARBER-COLMAN COMPANY

C, 1442 Rock Street, Rockford, Illinois

V.I.P. means Visual Integrated Presentation.
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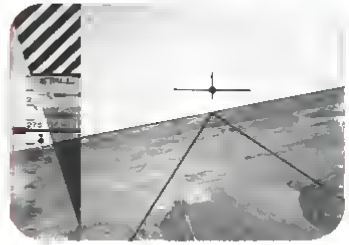

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working

machine's decision–space

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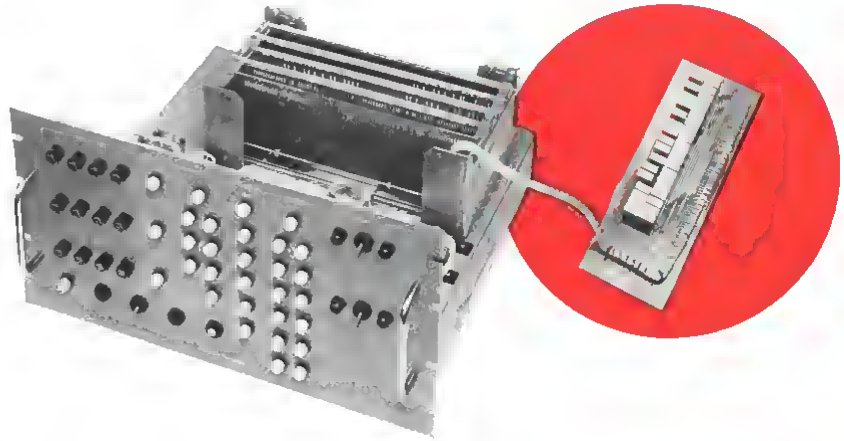

man's decision–place

living

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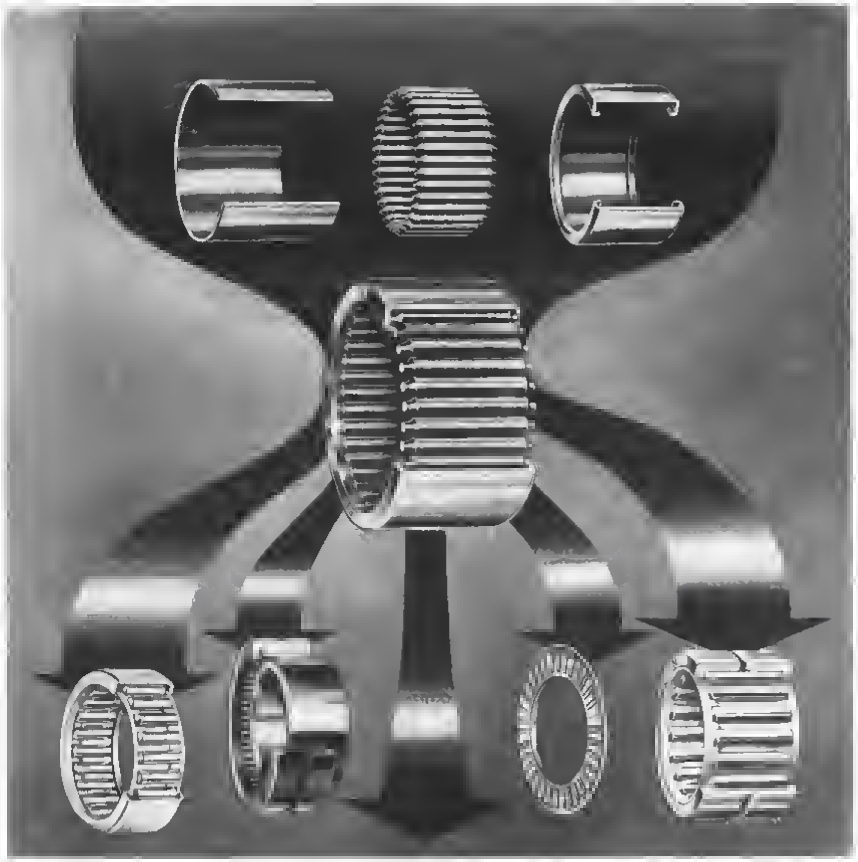

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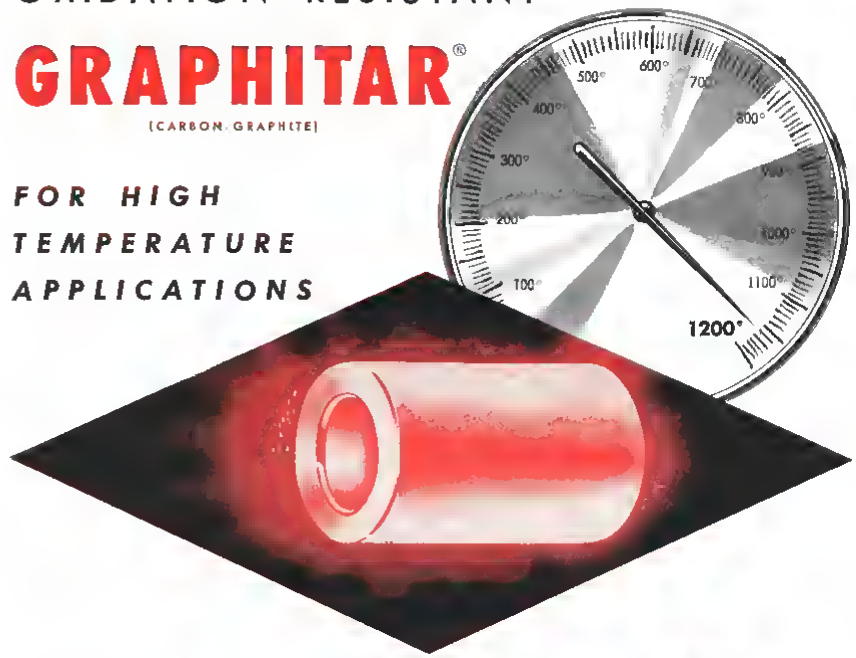

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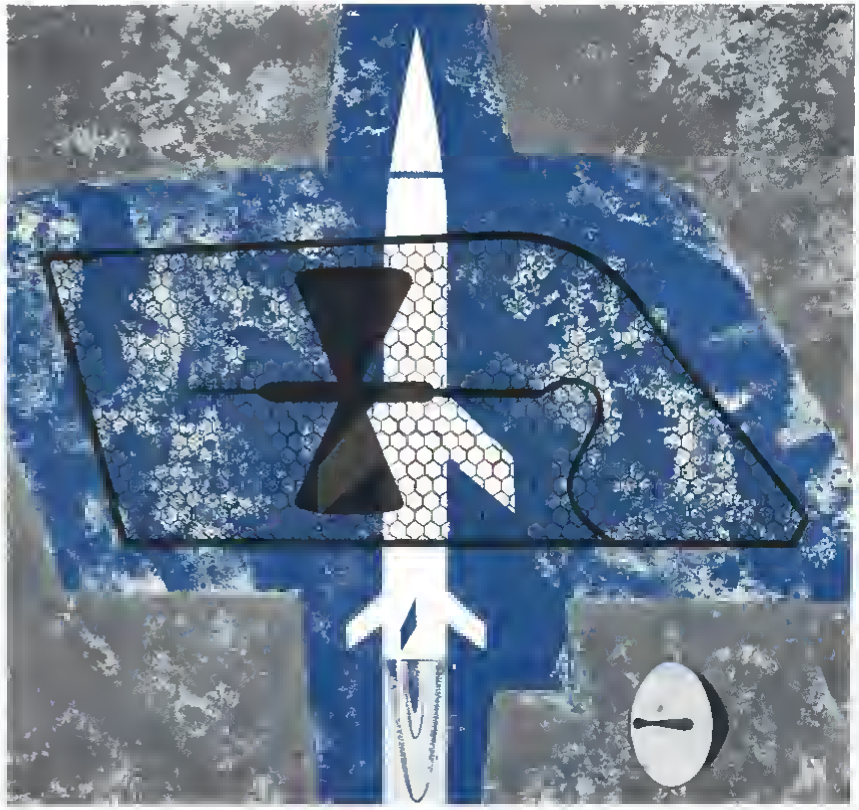

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Aviation Week and Space Technology

Volume 72
Number 10

March 7, 1960

TWENTY-SEVENTH ANNUAL INVENTORY OF AEROSPACE POWER

Aviation Week and Space Technology

Shifts in Aerospace Business Keep Sales on Plateau

Aerospace industry will rock along in 1960 on the $12 billion sales plateau it has held for the past two years. Declining sales of military aircraft are balanced by rapidly increasing sales of missile and space technology hardware, with commercial aircraft sales continuing to climb. Avionics share of both military and commercial markets is continuing to increase. Industry will split its sales about 80% military and 20% commercial and entered 1960 with a backlog of $11.5 billion.

Military expenditures for Fiscal 1961, key index to industry activity, will remain about the same as for Fiscal 1960 in these categories:

- **$6 billion for aircraft, including engines, airborne avionic systems, ground handling equipment and related equipment.**
- **$4 billion for missiles and related equipment, including rocket engines, guidance equipment, ground support environments and base construction.**
- **$1 billion for space technology research and development, including about $600 million from National Aeronautics and Space Administration and close to $400 million from the Defense Department.**

Commercial aircraft sales will total about $1.9 billion including jet transports, executive and private aircraft and helicopters.

Balancing the generally favorable business outlook of the aerospace industry for 1960 is a continuing decline in profit margins for major manufacturers. Average net profits after taxes for the 12 largest manufacturers in the aerospace industry declined in 1959 to slightly over 1% of sales compared with 2% in 1958 and 3.4% in 1954. This problem of declining profit margins in the face of relatively constant sales levels is the most acute problem facing the aerospace industry, particularly as it faces the prospect of increasing its own investment in research and development programs in relation to the proportion now borne by government expenditures. Military expenditures for research and development during Fiscal 1961 are expected to total about $4 billion of which the bulk will be for aviation, missiles, space technology and avionics.

Industry can expect some increase in military spending levels for last half of Fiscal 1961 and Fiscal 1962 as a result of major national debate on defense policies now in progress. Even though President Eisenhower is vigorously defending current policies and expenditure levels, retreats on several fronts have already been executed with resultant increases in key missile programs such as Atlas, Titan and Polaris; space boosters such as Saturn and Nova, and the airborne alert for Strategic Air Command which entails a higher purchasing level of turbojet engines, avionics' spares, fuel and other equipment.

Any major change in defense policy will have to await outcome of presidential election next fall, but strong defense planks are expected in platforms of both parties. Prospect of reaching any major disarmament agreement with Soviet Union is getting dimmer, particularly in view of French and Chinese bids for membership in circle of nuclear weapons producers. No major cutback in the defense program is in prospect.

Space technology will be most expansive area of industry, with heavy emphasis on the research and development phase. But appearance of first major hardware items such as Mercury manned space capsules, Centaur liquid hydrogen engines, weather, reconnaissance and early warning satellites will change the character of this activity.

Industry will watch closely the development of NASA policy regarding its ratio of "in-house" research and development in comparison with its contracting with industry. NASA officials state their primary policy will involve maximum industry contracting. Fiscal 1961 budget shows that of a $600 million total research and development budget only $51 million goes to "in-house" work, while $545 million, or more than 90%, goes to industry contracts.

Missile technology, which is still in its relative infancy, will fan out in several directions as second and third generation concepts appear to restore mobility via land, sea and air to what began of necessity as a fixed base operation.

Avionics, with its major contributions from miniaturization and solid state electronics, will continue to play a revolutionary technical role in the aerospace industry and account for an increasingly larger percentage of its total sales.

Air transport industry can look for a good year in traffic expansion, with about a 14% increase in prospect, but otherwise 1960 will present the major problems of transition to the jet age. The 14% traffic rise will not be sufficient to absorb the expanding rate of available seat miles as the larger capacity turbine-powered transports replace the piston engine fleet. This problem will become most acute next fall when major jet transport fleet deliveries will have been completed and is expected to last at least two years. Sharpest competitive battle in airline history to fill the capacious jet maws looms in prospect. Pressure for lower fares and other competitive differentials will increase.

Air coach traffic will continue to expand more rapidly than first-class following the pattern of the past five years. But carriers will try new patterns of pushing coach service hardest in areas where vacation travel is heaviest, curtailing coach service and pushing first-class in markets where business travel dominates.

Air freight will show substantial gains as more carriers divert piston engine aircraft from passenger to freight service. Big freight gains will await introduction of turboprop or turbofan equipment several years hence. Next major round of airline equipment buying is expected in the 1962-63 period, with cargo planes and medium-range jets as major items in filling out all-jet pattern. Airline profit margins will not increase during 1960 over last year as rising costs will keep pace with increasing gross revenues.

Business flying can look forward to another decade of spectacular growth matching its pace since 1950 when it doubled the number of planes delivered and increased its delivery values by six times due to increasing size and complexity of equipment. Last year, this segment of the industry delivered 7,732 planes having a retail value of about $212 million—an increase of 1,131 planes and $38 million over 1958. Of this total, 7,689 planes with retail value of $170 million were delivered by the traditional business plane manufacturers with about 43 planes valued at $43 million representing the initial increment of gas-turbine-powered executive planes delivered by Grumman and Fairchild.

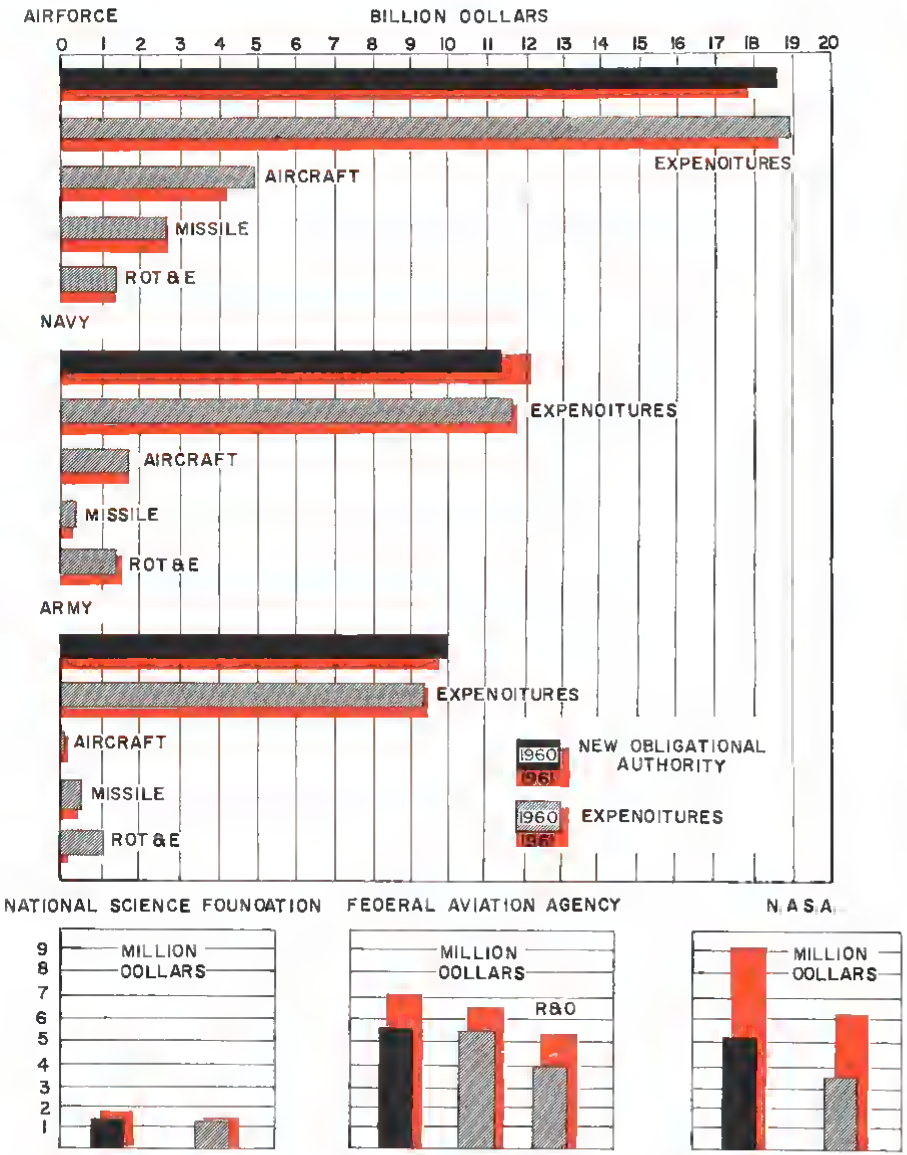
Government procurement policies and regulations, despite several recent revisions, have failed to keep pace with the rapidly shifting technology and military requirements moulding the aerospace industry. As a result, industry is finding it increasingly difficult to maintain a profit margin sufficient to modernize its plant, finance sufficient scale of research and development effort and divert its effort from other more profitable areas.

Biggest problem facing both aerospace industry and its federal customers is working out effective modern procurement relationships that provide sufficient flexibility and return on investment for industry to maintain the technical pace required and still provide taxpaying public with adequate safeguards against excessive profit and unsatisfactory performance by contractors.

Congress is currently studying the entire military procurement picture and hopefully, working with both government agencies and the industries concerned, will emerge with the basis of an effective modern procurement code that will function effectively to meet the twin requirements of the military services and the industry that serves them.

—Robert Hotz

Fiscal 1960, 1961 Aerospace Procurement, Research Funds



Boeing B-52G Stratofortress carrying two North American GAM-77 Hound Dogs

Military

USAF Molds Mixed ICBM-Aircraft Force

USAF is struggling with the problem of building a combat capability across the expanding technical spectrum of ballistic missiles, hypersonic aircraft and space technology in the face of constant level budget ceilings and rising costs of weapon systems.

"From its postwar peak of 414 combat squadrons and 925,000 military personnel, the Air Force has been reduced by the end of the budget year (Fiscal 1961) to 316 combat squadrons with 825,000 personnel," USAF Secretary Dudley Sharp recently told Congress.

Fiscal 1961 budget calls for a reduction of five combat wings and three support squadrons from the prior year, making a total cut of 14 combat wings and 26 support squadrons since Fiscal 1959. Aircraft inventory of the regular Air Force is scheduled for reduction to 15,008 by next June and 14,750 at the end of Fiscal 1961. Postwar peak of 18,860 aircraft was reached in 1956.

Against this decline in operational aircraft strength, USAF now has an operational strength of a single Atlas ICBM emplaced at its unhardened and undispersed training base at Vandenberg AFB, Calif. Two other Atlas missiles are in a state of near combat readiness on this base. Personnel of Strategic Air Command's First Missile Division have test fired two Atlas missiles from Vandenberg under simulated operational conditions impacting in the Pacific Missile Range.

USAF's biggest problem during the next four years will be to build an effective operational capability in ICBM weapons in the face of a similar effort by the Soviet Union that is now officially calculated to outgun the SAC ICBM force by a minimum ratio of 3 to 1. Other estimates indicate the Russians have a capability of widening the ICBM gap to 10 to 1 during this period.

IRBMs for Europe

USAF has no plans to deploy IRBMs within its own forces. It has provided the Royal Air Force with Douglas Thor missiles to stock a 60 missile complex at dispersed sites in England and will supply a trio of Chrysler Jupiter IRBM squadrons to Italy and Turkey.

After a year of heated political controversy, the Air Force ICBM program now calls for 27 squadrons of which 13 will be equipped with the Convair Atlas and 14 with the Martin Titan. Original Defense Department program called for 20 ICBM squadrons—9 Atlas and 11 Titan. Last year Congress specified an increase to 28 squadrons of which 17 were to be Atlas and 11 Titan. This program was shifted within Defense Department to eliminate one squadron because of base construction problems and to change three Atlas squadrons to Titan missiles. Current program was approved by Department of Defense and President Eisenhower in the face of opposition to any increase in the ICBM program by Army and Navy representatives on the Joint Chiefs of Staff.

Gen. Thomas White, USAF Chief of Staff, told Congress recently he would now like to expand the liquid fuel ICBM program although he did not advocate this course a year ago due to uncertainty as to the technical development of Atlas and Titan.

ICBM Funds

USAF plans to spend about $2.1 billion of its Fiscal 1961 $3 billion missile procurement budget for Atlas and Titan production and is asking for about $281 million for Fiscal 1961 in new construction authorization for ICBM base building.

Initial Atlas squadrons will have six missiles emplaced on a single site without hardening facilities and using a combination radio command and inertial guidance system. The Atlas squadrons in SAC will progress through an improvement program aimed at making them more difficult to destroy by counter missile fire and permitting faster reaction time to a firing order. Initial range of the operational Atlas will enable it to carry a warhead with more than one megaton yield about 7,200 mi. Later Atlas models are capable of improvement to deliver a multi-megaton warhead over 8,500 mi. ranges.

Fifth Atlas squadron will shift to a semi-hardened site with missiles still emplaced above ground but dispersed with each of the nine missiles on a separate site and the entire complex built to withstand overpressure of 25 psi from nuclear blasts. This squadron also will be the first of the all-inertial guidance squadrons permitting firing of all the squadron's nine missiles in a single salvo. Earlier combination radio command inertial guidance units can only fire a single missile at a time. Beginning with the eighth Atlas squadron the dispersed sites will be completely hardened to withstand 100 psi overpressure with the missiles encased in concrete silos and raised to the surface by an integral elevator for actual firing. Difference between surface firing from the elevator

ATLAS AGENA LAUNCHES MIDAS

● USAF

TITAN C with Avco Mk 4 nose cone

and in silo firing costs about 60 sec in reaction time. Convair has proposed a program to provide later Atlas squadrons with storable cryogenic fuel systems to speed reaction time but USAF has not yet added this feature to the SAC program.

All Titan squadrons will be in hardened sites and are planned for launching within the concrete silos. First six Titan squadrons will use standard liquid oxygen and kerosene fuel, but with the seventh squadron non-cryogenic storable fuels are scheduled. USAF has a $250 million research and development program scheduled to produce these storable liquid fuels for Titan.

Building up from virtually nothing at the beginning of 1960, USAF expects to have its 27 squadron Atlas-Titan ICBM force fully emplaced and operational by the end of 1963 at which time the first of the second-generation solid propellant Minuteman ICBMs are scheduled to become part of the combat inventory.

First Minuteman squadrons are due to become operational in hardened, in-silo firing sites early in 1963 even before the final Titan program is completed. Although the first Minuteman operational sites will stick to the hardened silo type base, USAF plans to abandon the fixed base concept for the bulk of its Minuteman strength and keep it mobile and dispersed on special missile trains operating at random over the nation's railroad network.

Soviet Mobility

The Soviets have already developed a mobile IRBM capability on trains and barges and are believed to be working toward similar capability with their ICBMs. Initial Soviet mobility goal is believed aimed at rapid transport of ICBMs by rail or air to preselected prepared sites for actual launch, with later capability sought for on-train launching.

Although USAF hopes for a major increase in its effective deterrent strength with the advent of Minuteman both from the larger quantities of the cheaper missile that will be available within budget limitations and also the missile's decreased vulnerability due to mobility, it plans to retain the Atlas and Titan forces because of a continuing requirement for delivering multi-megaton warheads on potential enemy targets. Gen. White told Congress there is a much smaller warhead yield available from the solid fueled Polaris and Minuteman missiles than from the more powerful liquid-fueled Atlas and Titan. Along with the mobile Minuteman, USAF is counting on development of an air-launched ballistic missile, the Skybolt, with a range in excess of 1,000 mi. to restore full mobility to its deterrent capability that will of necessity be anchored to bomber runways and fixed ICBM silos for the next several years.

Getting sufficient warning of an enemy ICBM and IRBM attack is the major problem in preserving the USAF deterrent force during this runway-silo concrete era.

BMEWS Capability

The Ballistic Missile Early Warning System (BMEWS) is aimed at providing about 15 min. warning of an ICBM attack, catching the missile about mid-way in its 30 min. trajectory. First BMEWS installation has been built at Thule, Greenland, a second is under construction in Alaska, and negotiations have just been completed for the third in Scotland. These 1,500 mi. ranging giant radars would have difficulty detecting single missiles or a few missiles with sufficient resolution to provide positive warning. Their chief value would lie in detecting any large scale salvo of ballistic missiles that would be required for an all-out surprise attack. However this system will not be in full operation for several more years, including the most critical years in the missile gap, and even when it is fully operational it could be flanked by special tactics or spoofed by decoys. SAC commanders are reluctant to depend on any information from BMEWS for positive action although it may be helpful in confirming or resolving information from other sources.

Better warning possibilities apparently lie in the future from the Discoverer satellite research program aimed at producing two operational orbiting reconnaissance systems—the Midas infrared early warning satellite and the Samos reconnaissance satellite. More than $500 million is currently being devoted to developing these systems with the Discoverer program aimed at obtaining the required engineering and operational data to produce the two systems. Midas would have the capability of detecting major ICBM launches and flights of ICBMs during their early stages and could furnish up to 30 min. warning if satellites were orbited to provide continuous coverage of potential launching areas.

Potential for Surprise

Nevertheless, many students of the surprise attack problem believe it would be impossible to prevent an all-out ICBM assault from achieving a high degree of surprise even with the presence of neutral inspectors at every ICBM launching base. Consequently, USAF planners are operating on the theory that their retaliatory power must be able to function despite a surprise attack if it is to maintain any real deterrent power. Any warning is considered an unexpected bonus, but the system must be operated to function

CONVAIR B-58 HUSTLER

whether there is adequate warning or not.

This is the crux of the problem Strategic Air Command is facing during the period when its own missile strength is inferior numerically to the USSR and is tied to fixed bases that would be high priority targets of any surprise ICBM assault.

SAC's answer to this problem for the foreseeable future—until the mobile Minuteman and air-launched IRBM restore mobility to the missile force—is a continuous airborne alert for its B-52 manned bomber force. SAC is currently getting only 14 of the 20 heavy bomber B-52 wings it has requested and there is little prospect that this force will be increased. Total of 704 B-52s have been programed for the SAC 14-wing heavy bomber force. The B-52G, featuring range increases and armed with Hound Dog offensive missiles and Quail ECM missiles, currently is being delivered to operational units. Final B-52 procurement increment will be for the B-52H powered by Pratt & Whitney TF-33 turbofan engines offering a substantial increase in range and maximum gross weight.

The SAC B-36 fleet has been completely retired and the B-47 fleet will begin to phase out this year as additional B-52 wings are added and the supersonic B-58 bomber enters the combat inventory. Gen. White credits the B-58 with 1,300 mph. top speed and operating altitude of over 60,000 ft. Initial increment of 30 B-58s is now operating as a test squadron at

USAF Aircraft on Order

Acft. Type	Popular Name	Manufacturer
Bombers		
B-52H	Stratofortress	Boeing
B-58	Hustler	Convair
Fighters		
F-105D	Thunderchief	Republic
Transports		
C-130B	Hercules	Lockheed
KC-135	Stratotanker	Boeing
Trainers		
T-37	None	Cessna
T-38	None	Northrop
T-39	Sabreliner	North American
Helicopters		
H-43B	Huskie	Kaman

USAF Missile Orders—1960

Missile	Mission	Manufacturer
Atlas	ICBM	Convair
Titan	ICBM	Martin
Snark	Intercontinental Air Breather	Northrop
Thor	IRBM	Douglas
Jupiter	IRBM	Chrysler
Hound Dog	Air-to-surface	North American
Quail	Air-to-surface	McDonnell
Bullpup	Air-to-surface	Martin
Mace B	Surface-to-surface	Martin
Bomarc	Surface-to-air	Boeing
Falcon	Air-to-air	Hughes
Sidewinder	Air-to-air	Philco
Genie	Air-to-air	Douglas

USAF

Carswell AFB, proving out subsystems and developing tactics that include low level penetration techniques. First operational B-58 wing is scheduled to be activated in SAC this summer. Total of 116 B-58s has been programed for SAC. Two B-47 wings are being deactivated for each new B-52 and B-58 wing that becomes operational in SAC, making a total of six B-47 wings scheduled to phase out in Fiscal 1961.

SAC now has a significant portion of its dispersed striking force on a ground alert, capable of getting into the air with its bomb load within 15 min. after receiving orders. This force can be launched on less positive warning than would be required for an ICBM salvo because it can be recalled for some time after takeoff. SAC feels this capability is sufficient to protect its retaliatory capability against any enemy assault by manned bombers but would be inadequate to meet the growing threat of an ICBM and IRBM salvo. To meet this latter threat in the period when its own missile forces will be relatively small and vulnerable, SAC proposes to put a significant portion of its B-52 bomber force on continuous airborne alert, thus serving ample notice to any potential aggressor that it cannot knock out this force with a missile salvo. SAC exercises have worked out airborne alert patterns that keep a fully loaded B-52 within range of its assigned targets about 90% of the time it is airborne in any given 24-hr. period.

To achieve this capability, SAC requires considerable stockpiling of spare engines, airborne parts, fuel and additional flight crews and maintenance personnel. An initial increment of about $100 million has been provided in the Fiscal 1960-61 budgets to begin this stockpiling, but these funds fall far short of what SAC feels it requires for an effective airborne alert.

This requirement will probably become one of the principal focal points in the debate of the adequacy of the Fiscal 1961 defense budget. Without the stockpiling of necessary spares and training of extra personnel during the next year, SAC will not have the capability to produce a continuous airborne alert if and when it is required during the period of maximum vulnerability during the 1961-64 period.

Meanwhile USAF is chafing over its inability to expand its current manned bomber force with additional B-52H and B-58 aircraft and the budgetary limitations imposed on its development of replacements for these aircraft. USAF firmly believes in the mixed force concept of ICBMs and manned vehicles complementing each other for particular military missions. To properly modernize this mixed force concept, USAF wants to continue its manned vehicle development through the Mach 3 B-70 bomber, the hypersonic Dyna-Soar program on to manned space vehicles.

In this area it is in conflict with Defense Department which leans toward complete dependence on missiles and which has drastically reduced funds available to USAF both for B-70 development and the Dyna-Soar program. Gen. White estimated the reduction of the B-70 program from an operational weapon system to two flying prototypes unequipped with military subsystems through a $381 million Fiscal 1961 budget slash will retard the possible achievement of an operational weapon system by at least two years.

Budget Slash

In lieu of the B-70 budget slash, USAF is considering a Mach 2.5 version of the B-58 powered by four Pratt & Whitney J58 turbojets as an interim replacement for its high speed penetration requirement. USAF is also continuing development of a nuclear powered aircraft with a $150 million Fiscal 1961 budget increment. This program has been reoriented to concentrate on developing a high performance airborne reactor with fuel elements that will give sufficiently high temperatures and long life for major aircraft performance improvements. Both the General Electric direct air cycle and the Pratt & Whitney indirect cycle approaches to the nuclear powerplant are being pursued. USAF says the nuclear-powered aircraft would provide an ideal continuous airborne alert mission vehicle armed with air-launched IRBM Skybolts.

USAF still feels the Soviet air force is its current major threat with its fleet of 1,200 medium and heavy gas turbine-powered bombers. Production continues of heavy jet bombers although at a rate lower than anticipated some years ago. Gen. White emphasized that, contrary to Nikita Khrushchev's statement that Soviet bomber production was being phased out, it was in fact continuing and the Russian bomber force in being was being maneuvered and exercised at an increasing tempo.

USAF will complete its early warning system designed to cope with manned vehicles and air-breathing missiles during 1960 with extension of the Distant Early Warning (DEW) line through the Aleutians to Midway Island in the Pacific and across the northern Atlantic to link with the NATO radar warning net that extends from the British Isles to Turkey. Major new projects will include construction of a huge computer in the United States to correlate and reduce data fed in from the BMEWS system and improved communications systems that will account for about $700 million in new avionic equipment in the Fiscal 1961 budget.

SAGE system for controlling both manned interceptors and surface-to-air interceptor missiles now has two of its eight programed supercombat centers operational and 11 of its 22 operational direction centers functioning. Fiscal 1961 budget calls for construction of three more super combat centers and three solid state computers for SAGE operations. Air Defense Command is phasing out the last of its subsonic interceptors, the F-86D and F-89 and will end 1960 with an all supersonic interceptor force equipped with radar and infrared guided missiles and nuclear tipped air-to-air missiles. ADC will have a manned interceptor force of F-102s, F-101s and Mach 2 F-106s.

First two Bomarc rocket plus ramjet-powered interceptor missile installations are now operational in the New York City defense complex at McGuire AFB, N. J., and Suffolk, Long Island. Total of $461 million is programed for Bomarc B, 400 mi. range advanced version of this interceptor missile. In the Fiscal 1961 budget, substantially completing the Bomarc production program. Bomarc program has been reduced from its original 32 bases to 16, including two in Canada to be operated by the RCAF. Each Bomarc site is scheduled to have 28 missile launchers.

Despite cancellation of the F-108 Mach 3 interceptor development program and the lack of any funds in the Fiscal 1961 budget for any interceptor aircraft, Gen. White made it clear to Congress that USAF is still planning to continue its development line of manned interceptor vehicles. Gen. White stated emphatically that regardless of the efficiency and reliability of missile interceptors and the growing problem of defense against ICBMs, USAF foresees a need for developing advanced manned interceptor systems to maintain the capability of patrolling, inspecting and policing its share of the sky. With the advent of the air-launched ballistic missile this requirement for long range high speed manned interceptors to identify and destroy enemy ALBM carrying planes becomes particularly acute, according to Gen. White. USAF is currently exploring an aluminum version of the F-108 which would be heat-limited in its top performance to below Mach 3, the B-58D, an interceptor version of the Hustler bomber powered by two Pratt & Whitney J58 turbojets with afterburner, and an adaptation of the Navy's A3J supersonic attack plane.

F-105 Phase-In

Tactical Air Command is primarily equipped with F-100 fighter bombers and a smattering of F-104s. It is beginning the major phase-in of the F-105 Mach 2 fighter bomber. Two wings of C-130B transports will be added to the three wings of C-130A turboprop transports now in service with troop carrier squadrons. TAC's main concern is polishing and perfecting its highly mobile composite striking force that was demonstrated, at least in prototype form, in the Lebanon and Formosa crises. TAC's major future interest is in development of a Mach 2 VTOL fighter bomber that will be capable of operating from unprepared fields anywhere in the world. Initial research and development funds for this project have been programed for Fiscal 1961 as part of a $36 million fund devoted to this project and to improvements of the Bullpup air-to-ground missile for TAC.

Military Air Transport Service has had its wings clipped by the recent presidential directive confining it primarily to its military mission and shifting the bulk of its routine passenger and ordinary cargo transport to commercial contract carriers. It will continue to operate 27 transport squadrons, including three Navy squadrons, but faces a major modernization program with the bulk of its fleet consisting of obsolescent piston-powered transports. Increment of 50 turboprop-powered C-133 transports is the only relatively modern equipment now programed for MATS, but the Fiscal 1961 budget contains a $51 million item earmarked for development of a modern military cargo transport. This is expected to be either a turboprop or turbofan-powered transport.

USAF will shift to an all-jet pilot training program in 1960 with the twin-jet T-37 used for primary training and the supersonic T-38 replacing the T-33 for advanced training.

Initial procurement of the twin-jet T-39 utility transport and proficiency flying aircraft will also be made with Fiscal 1961 funds. Pilot training rate will drop to a steady level of about 1,500 annually by the end of Fiscal 1961 with an equal output of bombardier-navigators scheduled annually. USAF has recently altered its regulations to permit nonrated officers to command operational missile units and has taken 2,100 rated officers off flying status to meet its problem of shrinking cockpit space in the mixed force operation.

USAF Wing Strength

Fiscal 1959 (Combat Wings)	
Strategic Wings	43
Air Defense Wings	27
Tactical Wings	35
TOTAL	105
(Support Squadrons)	
Air Refueling Squadrons	60
MATS Squadrons	27
"Other Specialized Squadrons"	58
TOTAL	145
Fiscal 1960 (Combat Wings)	
Strategic Wings	40
Air Defense Wings	23
Tactical Wings	33
TOTAL	96
(Support Squadrons)	
Air Refueling Squadrons	62
MATS Squadrons	22
"Other Specialized Squadrons"	34
TOTAL	118
Fiscal 1961 (Combat Wings)	
Strategic Wings	35
Air Defense Wings	20
Tactical Wings	33
TOTAL	91
(Support Squadrons)	
Air Refueling Squadrons	66
MATS Squadrons	21
Other Specialized Squadrons"	28
TOTAL	115

LONE U.S. OPERATIONAL ICBM—CONVAIR ATLAS EMPLACED AT VANDENBERG AFB

MCDONNELL F4H Phantom II making its first carrier landings. Chance Vought F8Us and Douglas A3Ds are parked on the deck of the carrier, the USS Independence.

Navy Enters Ballistic Missile Age; Fund Battle Looms

By Cecil Brownlow

Navy this year is breaking into the ballistic missile age and an open battle with the Air Force over missions and money.

To finance its new responsibilities, including the launching of military satellite vehicles, the Navy is stretching its Fiscal 1961 budget thin, and major compromises already have been made.

Demands for a second nuclear carrier for the fleet have been pared within the Defense Department to a request for a conventionally powered Forrestal-class carrier. Total number of ships in the active inventory is being reduced, manpower is being cut by approximately 11,000, and Navy spokesmen say the research and development funds for anti-submarine warfare projects in the Fiscal 1961 budget are $100 million below what they should be.

Operationally, the Navy is scheduled to become a ballistic missile power in September when the Polaris goes aboard the nuclear submarine George Washington. Initial range of the Polaris—which Navy hopes to eventually stretch to 3,000 mi. and beyond—will be approximately 1,200 mi. A second Polaris submarine, Patrick Henry, is scheduled to become operational in December.

The Polaris system—how it should be deployed and its relative vulnerability—is one of Navy's main points of contention with the Air Force.

USAF, in a proposal first made over a year ago and now being pushed again, says all U. S. strategic forces should come under a single command for the purposes of coordinated control and that the logical agency for this is the Strategic Air Command.

Although Air Force Chief of Staff Gen. Thomas D. White has stated publicly that, if SAC is unacceptable, an over-all strategic command should be created with either an admiral or a general at its head, Navy opposition has been adamant and consistent.

In a written report to a House appropriations subcommittee earlier this year, Adm. Arleigh A. Burke, chief of naval operations, said the proposal "completely ignores the fact that, in the case of missile submarine operations, the prime requisite is for coordination of the submarines prior to the launching of the missiles." The report concluded that any move to "remove Polaris submarines from our operating fleets and lump them into an over-all strategic command is both impractical and dangerous."

The Air Force plan, nevertheless has been recirculated among the three services for comment and is scheduled to be placed on the desk of the secretary of defense sometime this month.

Navy eventually plans a total of approximately 45 Polaris submarines, each carrying 16 missiles, with as many as 25 on station at a time. If Congress goes along with Navy requests, including a planned supplemental to the regular Fiscal 1961 budget, 18 of the submarines will have been funded through Fiscal 1961.

The solid propellant Polaris also is viewed by Navy as the logical vehicle to provide it with its own space boosters, used either singly or clustered around a plug nozzle, in order to bolster its position within the military space hierarchy—another sore point in Air Force-Navy relations.

Small gains have been made by the Navy over the past year in an effort to establish itself firmly as a space service, but it lost out last summer in a bid to gain a major share in the U. S. military program.

Navy bid included a proposal for the establishment of a Military Space Command to run space system operations, with the individual systems assigned on an equal basis among the three services for actual operation. The plan never left the Joint Chiefs of Staff level, however, and Air Force subsequently was given responsibility for development, production and operation of all U. S. military space boosters.

Over-all Navy wants navigation, meteorological, communications, reconnaissance and early warning satellite systems responsive to interrogation by ships at sea and aircraft in flight.

Navy Space Gains

It has made its greatest political gains in the navigation satellite field with Project Transit, an Advanced Research Projects Agency system under Navy management. Designed primarily to fit into Navy's fleet ballistic missile system, Transit is being developed to provide a Polaris submarine with a navigational fix within one-tenth of a mile of its actual position.

In an effort to save funds, Navy is currently reducing Transit's initial payload size from 270 lb. to 50 lb. in order to use the relatively-inexpensive Scout solid propellant booster under development for the National Aeronautics and Space Administration rather than the liquid-fueled Thor-Able vehicle originally planned.

Another low-cost space system now under study is a photo reconnaissance satellite designated Project Yo-Yo that could be launched from a ship or submarine, make a single pass around the earth and over the target area, then be recovered at sea.

In the battle for the sparse funds allowed under Defense Department Fiscal 1961 budget requests, Air Force and Navy also are clashing over the priority, and worth, of specific weapon systems and missions.

Adm. Burke has described the Polaris weapon system as one with "an inherent high degree of invulnerability." Gen. White called it one that "will contribute significantly to our over-all retaliatory capability," but is "certainly not invulnerable."

Adm. Burke, in obvious reference to the six ballistic missile submarines the Soviets are believed to have in operation, says he considers anti-submarine warfare a greater problem than air defense and that Fiscal 1961 funds Air Force wants for a limited SAC airborne alert capability are unnecessary.

Gen. White told a House appropriations subcommittee that he opposed Navy's bid for a new carrier in Fiscal 1961 budget debates within the Joint Chiefs of Staff because "its relative cost compared to its capabilities in the nuclear age is too great." Adm. Burke told the same subcommittee that the carrier "is vitally important" if Navy is to maintain effectively its tactical war capability.

As the Fiscal 1961 budget now stands and with the carrier request still intact, Navy will be allowed to order 658 new aircraft, down slightly from the 689 programed in Fiscal 1960.

In an effort to gain the most combat capability within this framework, Navy has trimmed the types of aircraft it will buy from 16 in Fiscal 1960 to 12 under a program which provides for no administrative or training planes.

Major Navy effort is currently centering around the Missileer competition now under way to provide a subsonic carrier-based aircraft with a 50,000-lb. gross weight to serve as a platform for the Eagle long-range air-to-air missile.

Industry proposals for the aircraft which the Navy would like to build around an existing airframe if possible, were received late last month, and a final decision is expected in the near future.

Another outgrowth of Navy's "slow-plane" concept, the Grumman A2F attack plane, is scheduled for rollout sometime this spring. Main feature of the twin-turbojet A2F as originally laid down by Navy is a design speed of Mach .9 at sea level to permit the aircraft to slip beneath defensive radar networks. A2F also has been mentioned favorably as a possible Missileer airframe.

A low-altitude capability is now being crammed into the North American Aviation A3J-1 which was designed primarily as a supersonic, high-altitude penetration weapon system. Final funds for production of the A3J at North American's Columbus, Ohio, plant are in the Fiscal 1961 budget requests.

Aircraft Buying Plans

Navy decision to buy only combat aircraft, scrapping plans to go to an all-jet basic training program, also puts a crimp into the Columbus Division's production schedule, since no funds are provided for the T2J-1.

Other aircraft and helicopters scheduled for funding under Navy's Fiscal 1961 budget requests include:

- **McDonnell F4H Mach-2-plus** all-weather fighter powered by two General Electric J79 turbojets and now undergoing carrier trials. Navy plans to buy the F4H in "significant numbers."
- **Chance Vought F8U-2N** fighter, with a "limited" all-weather capability and a top speed approaching Mach 2. Aircraft is powered by the Pratt & Whitney J57 P-20, which provides a thrust of well over 70,000 lb. with afterburner.
- **Douglas A4D-2N**, all-weather version of the A4D, powered by a 7,200-lb.-thrust Curtiss-Wright J65 engine.
- **Grumman W2F** Airborne early warning aircraft powered by two Allison T56 turboprop engines and scheduled as an eventual replacement for the Grumman WF-2 which is now being introduced into fleet squadron service. W2F rollout is scheduled for this spring.
- **Grumman S2F-3**, improved version of the S2F carrier based submarine hunter-killer, powered by two Curtiss-Wright R1820 piston engines.
- **Lockheed P3V-1**, long-range shore-based submarine search plane built around the airframe of the Electra turboprop transport, to replace the P2V. Powerplants are four Allison T56 turboprop engines.
- **Lockheed GV-1**, tanker version of the Air Force C-130, is being purchased for use by the Marine Corps.
- **Gyrodyne DSN-3** drone helicopter for use aboard destroyers with anti-submarine weapon packages in connection with Navy's Dash ASW program.
- **Kaman HU2K-1** utility helicopter powered by a General Electric T58 1,050 eshp. turboshaft.
- **Sikorsky HUS-1** Marine transport version of the HS-1.
- **Sikorsky HSS-2** submarine search

Navy Planes on Hand
(End of Fiscal Year)

1958	8,424
1959	7,562
1960	6,850*
1961	6,800*

*Planned

LOCKHEED P3V-1 ANTI-SUBMARINE WARFARE AIRCRAFT

Navy Aircraft, Missiles on Order—1960

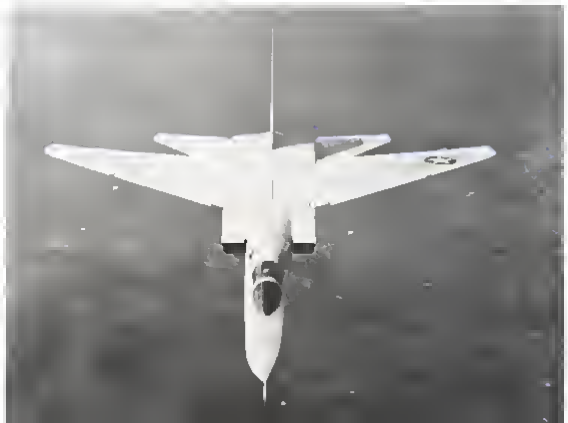
COMPANY	PLANE	NAME
FIGHTERS		
Chance Vought	F8U 2N	Crusader
McDonnell	F4H 1	Phantom II
ATTACK		
Grumman	A2F 1	
North American	A3J-1	Vigilante
	A4D-2N	Skyhawk
PATROL		
Grumman	S2F-3	
	W2F-1	
	WF-2	
Lockheed	P2V-7	Neptune
	P3V 1	
TANKERS		
Lockheed	GV-1	

COMPANY	PLANE	NAME
HELICOPTERS		
Gyrodyne	DSN-3	
Kaman	HU2K-1	Seasprite
Sikorsky	HSS-2	
	HUS-1	
	HSS-1N	

COMPANY	NAME	TYPE
Lockheed	Polaris	ballistic
Raytheon	Sparrow III	air-to-air
Philco	Sidewinder	air-to-air
Martin	Bullpup	air-to-ground
Convair	Terrier	surface-to-air
Bendix	Talos	surface-to-air
Convair-APL*	Tartar	surface-to-air
Raytheon†	Hawk	surface-to-air

* Applied Physics Laboratory † On order for Marine Corps

NORTH AMERICAN A3J VIGILANTE



helicopter powered by two General Electric T58s

Aircraft and helicopters procured under the Fiscal 1960 budget but with no funding in Fiscal 1961 include the Grumman WF-2 North American T2J-1, Lockheed P2V-7 and the HSS-1N, a version of the HSS-1 instrumented to fly in bad weather and at night

In air-to-air missiles Fiscal 1961 requests include funds for continued production of the Raytheon Sparrow III now going to the fleet with a Thiokol storable liquid propellant powerplant, and an improved radar guided version of the Sidewinder. Radar-guided Sidewinder will be used to improve the all-weather capability of the F8U-2N and will be used with the Sparrow IIIE on the F4H to give the aircraft a dual mode of attack.

Research and development funds also are being requested for the Bendix Eagle weapon system.

Production funds are being requested only for the Martin Bullpup in the air-to-ground category, plus research and development funds for continued development of the 100-mi. range Temco Corvus, which is designed to home in defensive radar installations.

Surface-to-air procurement plans include the Convair Terrier and Bendix Talos for cruiser-size ships and the Convair-Applied Physics Laboratory Tartar for smaller vessels. Navy also has under serious study plans for small solid-propellant surface-to-air missiles for use aboard destroyers and possibly smaller ships.

Possibly the biggest hurdle Navy will face in attempting to push its Fiscal 1961 budget through Congress is its request for a conventional-powered carrier.

The same request last year was denied, with Congress providing funds for long lead-time items for a second nuclear carrier to go with the Enterprise which is now under construction and scheduled to join the fleet in 1962.

Navy, however, is faced with budgetary restrictions plus the present high operating costs of nuclear-powered vessels and is repeating its request for permission to build a conventional carrier instead. Initial cost of a four-reactor nuclear carrier as originally planned would be approximately $130 million more than the $293 million needed for a Forrestal-class carrier. Cost of the eight-reactor Enterprise now under construction is estimated at approximately $471 million.

Operating costs of a nuclear carrier probably will be approximately four times those of a conventional ship, based upon Navy's experience with its nuclear-powered submarines.

ASW Research

Navy also is continuing its assault this year on the problems of anti-submarine warfare. Urgency of finding methods of increasing detection ranges, improving localization and classification techniques and of introducing more sophisticated ASW vehicles has increased with the appearance of Soviet ballistic missile submarines—three of which are believed to be in the Atlantic with the other three in the Pacific. It will become even more urgent if the Soviets launch a nuclear-powered submarine this year as expected.

Overall, approximately 29% of Navy's Fiscal 1961 procurement requests including research, development, test and evaluation are devoted to anti-submarine warfare projects. This includes $340.1 million for aircraft procurement, $762.3 million for ship construction, $25.5 million for electronics, $150.5 million for RDT&E and $56 million for ordnance and ammunition.

Major improvements in detection devices and techniques have been made since the Navy belatedly accelerated its ASW research program approximately three years ago although primary reliance still has to be placed with relatively unstable sound systems.

Range and reliability of the detection devices also have improved to the point where the Navy believes it "can hurt nuclear-powered submarines and handle a good many of them."

Research Programs

Research programs include Project Artemis described by Adm. Burke as a "program to establish the feasibility of ocean area active sonar surveillance," and infrared and advanced magnetic detection techniques.

Navy also will begin placing Gyrodyne DSN-3 drone helicopters aboard destroyers and destroyer escorts this year in an effort to offset the speed advantage nuclear submarines have over these largely World War II vessels. Under this Dash concept, Navy will rely upon the surface ships to detect, classify and locate the submarine, then send the torpedo-equipped drone helicopter in for the kill.

Also under consideration are two-man, low-cost hydrofoil vessels equipped with ASW torpedoes and missiles that would be launched from mother ships when a submarine was believed to be in the area.

In an organizational move to shore up its ASW defenses the Navy is establishing a command within the Pacific Fleet similar to the Anti-Submarine Defense Force that has been in operation with the Atlantic Fleet for the past several years. The new Pacific Command will be headed by Rear Adm. John S. Thach, first commander of Task Force ALFA established in early 1958 to try and determine through fleet exercises the problems confronting an effective ASW program.

CONVAIR ADVANCED TERRIER

MARTIN BULLPUP BEFORE LOADING ON DOUGLAS A4D

Army Weighs Aviation Policy Decision

By J. S. Butz, Jr.

Washington—U S Army aviation research and development policy for the first half of the decade will become firmly set next week, aiming to ensure that the Army will have modern aircraft to operate in the last half of the period.

Army leaned heavily upon industry's estimate of the current and future technical state-of-the-art to help it meet its self-imposed policy formulation deadline of Mar. 15.

Aviation and electronic firms were asked at a conference Dec 1 to submit their ideas on the best technical course for Army aviation to pursue during the next five years regarding its three major aircraft missions. These industry ideas were submitted on Dec 15 and the Army announced that a policy decision would be made within three months for the following missions close observation of the battlefield, surveillance of the enemy's rear, and forward area transportation of troops

All of these aircraft will be unarmed except for the protection of their occupants as stipulated by Department of Defense directive. Army's requirement to bring enemy troops under fire is satisfied dually by its own missiles and artillery and the Air Force's Tactical Air Command

Main design objective with Army's new generation of battlefield missiles is to improve mobility, reaction time and simplicity These weapons, which have received much more financial support than the Army's aircraft program, all use solid propellant rocket engines in contrast to the first generation missiles which used liquid fuel engines almost entirely

The second generation of bombardment missiles includes the 75-mi plus range Sergeant that will replace the Corporal the 700-mi-plus Pershing to replace the Redstone; Lobber, a new type of rocket designed to deliver supplies as well as attack the enemy within a 15-mi. range Little John, an unguided ballistic missile with 10-mi range to supplement the larger 15-mi operational Honest John and operational 20-mi range Lacrosse guided weapon, Missile A, a 75 mi range missile of very simple design intended to complement the previous group of weapons, Davy Crockett, a bazooka-launched close support missile with a small nuclear warhead for use at battalion level, Shillelagh, a close support missile which can be mounted on small vehicles, and the French-made Nord SS 10 and SS-11 surface-to-surface wire guided missiles for use against point or moving ground targets.

Two new anti-aircraft missiles for battlefield use are also being developed by the Army They are the Mauler crew-served weapon and the Red-Eye shoulder fired missile, both of which use infrared guidance.

SERGEANT has speed brakes (between fins) providing variable drag for range control.

Aircraft Missions

Four general policies or some combination of them are possible in each of the aircraft categories, according to Army officials

- **Development of new aircraft** of advanced performance after a design competition and source selection action
- **Steady improvement** of existing operational aircraft and those presently under development
- **Increased research effort** to advance the state of the art required to successfully develop new aircraft with significantly increased performance
- **Flight competitions** among completed aircraft to choose which to produce

Army hopes that creating a crystal clear aviation policy will not only improve the technical air but also will aid its position at the Administration's budget table. With a definite long range plan Army will be able to estimate aviation costs very closely over the next few years for fiscal officials in the Department of Defense The desire is to get away from a year-to-year financing by obtaining a general agreement as to just what the program will be over a period of several years and what amount of money will be available to carry it out

Present estimates are that this program must be held to the current level of $100 to $150 million a year for the development of new aircraft Large production orders for any advanced aircraft are several years away and allocating the funds for such aircraft will be discussed in the future There have been estimates recently that the Army will be the nation's largest operator of manned aircraft by 1970 but this would require a basic change in Army policy if its aviation branch is to be heavily supported The number of Army aircraft was about 5,500 last year and this number has not changed significantly for some time Pilot training is scheduled to remain at 500 rotary wing pilots and 730 fixed wing pilots per year Most of the rotary wing pilots have received the fixed wing training before they enter that course.

Mobility Problems

Lack of significant success in three areas continues to remain as the main obstacle to putting the troops in "flying trucks" and giving them the mobility needed to be effective against much larger forces, although the performance that the Army can expect from its aerial equipment has improved a great deal in the past few years These three critical areas are

- **High thrust-to-weight ratio** engines which will make VTOL/STOL aircraft competitive with current aircraft in payload carrying ability VTOL/STOL performance is considered absolutely necessary to free the Army from its logistical dependence on roads and to give it the speed needed for effective atomic battlefield movement
- **Greatly simplified maintenance** so that aircraft can be serviced in the field for extended periods by relatively unskilled personnel operating with only a small tool kit in the crudest types of shelter
- **Large reduction** in engine fuel consumption. Total fuel requirements for tactical operations in which aircraft rather than trucks are used to transport troops have long caused concern among army officials These requirements are so high today that a sizable percentage of the available aircraft during any lengthy combat period must be used to carry fuel for those doing useful work with the troops

Number of Operational Aircraft
U. S. Army

30 June, 1956	3,450
30 June, 1957	4,525
30 June, 1958	4,606
30 June, 1959	5,440
1 January, 1960	5,430

Progress in the engine field is being made with much of it under Army sponsorship, but it has been slower than it could have been because rapid engine development programs are extremely expensive As far as thrust to weight ratios are concerned, 7 or 8 lb of thrust per pound of engine weight is considered good Some engine engineers believe that 10 1 could be achieved if another generation of engines is placed under development It will probably be necessary, however, to have engines with a 12 1 ratio or better if small VTOL aircraft capable of being used near a front line are going to be very efficient as a troop and supply transport

Some Army planners believe that a 50% reduction in battlefield fuel requirements must be made if frontline troop movements by air are to become a common practice during a large scale war. Few engineers believe that a 50% reduction in current turbine engine specific fuel consumptions can be made in the next 10 years regardless of the support that such a program would receive A 25% reduction in the aircraft requirements would mean several more years of difficult engine development work with maximum funding support and luck

Ground vehicle type maintenance ease probably will not come until aircraft performance is so good that a large percentage of it can be sacrificed to very rugged simplified construction Just when the Army can call for this type of design in its aircraft is uncertain but it certainly will be after increased engine performance is achieved.

Army is sponsoring three turbine engine development programs at present in three different power classes Smallest is the Allison T63, which will produce 250 shp and is one of the few engines allowed to enter development by the Department of Defense without being part of some specific weapon system. This engine was originally conceived as a state-of-the-art advance which would generate weapon and aircraft requirements as it neared production.

The medium power engine in the Army group is the Lycoming T53, 800 to 1,000 shp engine in production in its turboprop version of the Grumman Mohawk observation aircraft and in its turboshaft version for the Bell Iroquois helicopter The Lycoming T55 of 1 800 to 2,200 shp is nearing production for the Vertol YHC-1B Chinook two-ton payload helicopter

Only advanced Army propulsion unit which is receiving significant financial support is the General Electric lift fan

PERSHING, shown during first launching, is 700 mi range replacement for Redstone.

which is operated by diverting a jet engine exhaust flow into a scroll and then passing it through small turbine blades on the tips of large fan blades. Transferring the jet engine power in this way to a large diameter fan greatly increases the static thrust available for takeoff of any aircraft using the engine. Money has been provided to produce enough hardware to get a good experimental check on this system and the tests are in progress.

Most officers believe that air defenses on future battlefields will be so good that the Army's flying will have to be done at treetop level to take advantage of all available cover if heavy losses are to be avoided. Most aircraft that operate tactically at any altitude above the trees probably will be unmanned and will fly at very high speeds to keep their attrition rate acceptable.

Aircraft Programs

Army now has four aircraft programs which are under way at present. The Bell HU-1 is now going to troop units. It is the first turbine-powered helicopter used by the Army. The Grumman AO-1 Mohawk high speed observation aircraft is now entering its engineering test phase. The de Havilland of Canada AC-1 Caribou frontline transport aircraft which was bought as an off-the-shelf item is undergoing service tests by the Army Aviation Board at Fort Rucker, Ala. The Vertol YHC-1B helicopter is in the last portion of its design phase.

Aircraft and aviation equipment development in the Army is handled by the Director of Army Aviation and the groups which report to him in Army headquarters in the Pentagon. Brig. Gen. Clifton von Kann holds this post. Test work is under the direction of the Army Aviation Board at Ft. Rucker.

A new aircraft development cycle in the Army averages about 5¼ years from the time a definite requirement is initiated until quantity production begins. Another year is usually required to get the first squadron equipped.

This cycle is split into seven distinct steps. The first is to complete the requirement. This is handled by cross-feed between the Pentagon planning groups and takes nine months if all goes well. Three months are then allowed for the Army Aviation Board to make certain that this requirement document is compatible with the latest needs of the troops in the field. The Board's main function is making service tests from the standpoint of the using com-

CONVAIR Red Eye is composite missile containing propellant, guidance and warhead.

mands rather than making strictly engineering evaluations. It feeds its knowledge back into the Army system through liaison officers stationed with planning and engineering groups but the Board also has this three-month period in the early part of the development cycle when it is in primary charge of each new project.

After the Board completes the military requirements presentation the cycle moves to another nine month step in which the detailed engineering specifications are set down. Design contracts are then let to industry with about 15 months allowed for this phase. Experimental prototypes are also produced during the design period and their acceptance begins a month or so before it is over. This initial testing period normally covers about 18 months and it is handled primarily by the contractor. It is followed by a service test program at Ft. Rucker which covers 13 to 14 months. Quantity production usually is ordered after the service test program has been in progress for eight months.

Critics of the Army aircraft development cycle both outside and within the service believe that the cycle should be reduced by as many as two years so that combat requirements can be reflected in tactical equipment more rapidly and the degree of obsolescence of Army equipment can be reduced even though the pace of technological advance continues to increase. Most of the critics believe that the biggest time reductions can be made during the two and one half year testing phases and by making the engineering specifications laid down by the Army for each aircraft more general so that the nine months required for this step could be cut by at least 50%. All steps in the cycle could be reduced somewhat, according to most critics. They believe that long development programs cost the Army a great deal of money with little improvement in the quality of the product they finally operate.

One prominent exception to the normal Army development procedures has been made in the case of the Marvel STOL observation aircraft being designed and tested by the Aerophysics Department of Mississippi State College headed by Dr. August Raspet. It is hoped that after prototype testing is completed by the university group and a short operational test program is conducted by the Army Aviation Board the aircraft can be turned over to a manufacturer for quantity production.

A major increase in flight efficiencies is being attempted with the Marvel aircraft. It is designed to fly 350 mph on only 250 hp and its landing speed is estimated at 35 mph. This difference between top speed and landing speed by a factor of 10 compares with speed

range factors of about three for most contemporary subsonic aircraft. The Marvel is expected to take off and land with less than 150 ft. ground roll.

Five relatively new concepts will be combined on the Marvel. They are suction-type boundary layer control on the wing and in adverse pressure regions on the fuselage; glass fiber construction; camber-changing wing rather than a wing with flaps for high lift; ducted propeller on the rear of the aircraft; and a pitch and directional control system composed of flaps on the shroud around the propeller.

Considerable experience has been gained in the past with all these ideas except the control system. This is the first time they have been combined on to one aircraft. If the Marvel proves to be a complete success, the Army's short field landing and fuel consumption problems will be reduced several times. Prototype of the Marvel is scheduled to fly for the first time in July, 1961. Its powerplant is the Allison T63.

Combat surveillance is one of the major problems facing the Army. A special office located in Arlington, Va., the U.S. Army Combat Surveillance Agency has been created to improve the Army's ability in this area. Since this problem is highly technical and most of the techniques which can bring about large improvement in reconnaissance capability are in an early stage of development, a special technical group was organized over two years ago to assist the surveillance agency. Generally following the Air Force pattern set by the Ballistic Missile Division and Space Technology Laboratories, the surveillance agency's technical advisor has been the Combat Surveillance Project operated by the Cornell Aeronautical Laboratory.

Magnitude of the surveillance problem is indicated by the objectives of the agency in charge. Surveillance agency must find ways to present four basic types of information almost instantaneously to commanders on the nuclear battlefield. Commanders may be unable to make competent decisions without these four categories of information, which are coordinates of potential targets over an area of many hundreds of square miles, detection of intrusion or infiltration of enemy forces between widely separated units, assessment of the biological dangers produced by all nuclear blasts both hostile and friendly, and assessment of damage which has been sustained by the enemy and friendly troops. The need for rapid and accurate reports to an area commander and a foolproof method for him to issue commands is absolutely necessary if small troop units are to move about an atomic battlefield in response to any sort of plan. It is believed that profit-

BELL HU 1A Iroquois carries six Nord SS-11 missiles on side-mounted racks

able targets will remain so for very short periods and that rapid coordinate data will be necessary for both bombardment or engagement by ground forces to be effective

Current surveillance plans have relied heavily on the use of drones and manned reconnaissance aircraft to provide the types of data needed It is believed that the Army aviation policy decision due Mar 15 will contain some major changes in this plan More aerodynamically sophisticated vehicles may be called for to carry the necessary reconnaissance equipment These will be unmanned if they are to operate extensively over enemy ground One of the Army requirements known at present is for a new manned aircraft for observation close to friendly troops which will replace the Cessna L-19

Army officials say that a long list of equipment is being considered for use as sensors in these reconnaissance vehicles and on the ground The most prominent ones are optical aids photography, television, passive and active infrared, radar, flash- and sound ranging sets, and seismic and acoustic devices When such units are used in flying vehicles, the vehicle must have an accurate guidance unit if the data which is gathered is to be useful There must be units to either record the data or to transmit it immediately to a ground station Once this information has been transmitted to a central point there is the problem of reducing it to a usable form The volume of data which can be gathered by even a small number of modern reconnaissance units makes the usefulness of existing data processing and presentation equipment doubtful A major portion of the activity of the Army Combat Surveillance Agency is devoted to developing smaller units of this type which can do more work This new processing and presentation equipment will also postulate answers to involved operational problems so that the commander's decision-making time might be reduced

Army Aircraft on Order—1960

Company	Name	Type
Grumman	AO-1 Mohawk	Observation
De Havilland	AC-1 Caribou	Assault transport
Bell	HU-1 Iroquois	Helicopter
Bell	H 13 Sioux	Helicopter
Bell	H 23 Raven	Helicopter
Vertol	HC 1B	Helicopter

Army Missiles on Order—1960

Company	Name	Type
Sperry	Sergeant	Surface to-surface
Emerson Electric Douglas	Honest John	Surface-to surface
Emerson Electric	Little John	Surface to surface
Martin	Lacrosse	Surface-to-surface
Raytheon	Hawk	Surface-to-air
Rock Island, Picatinny and Frankfort Arsenals	Davy Crockett	Surface to-surface
Douglas	Nike Hercules	Surface-to-air
Convair	Red Eye	Surface-to-air
Firestone	Corporal	Surface to-surface
Chrysler	Redstone, Jupiter	Surface-to-surface
Nord	SS 10, SS 11	Surface-to-surface

BATTLEFIELD mobility for troops—a NATO problem—is tested using de Havilland of Canada AC-1 Caribous.

NATO Capability Rises Despite Problems

Paris—Increased retaliation capability, improved reaction time and strength build-ups across the board characterized NATO's progress during 1959. All is not brightness, though. There are major problems to be solved in the political area, communications need improving and early warning systems still are incomplete.

Things are much better now than they were two years ago," said one general. "But you can always say things are better this year than they were last. What I really mean is that I think we could give the Russians a beating if they moved right now."

The strength of that opinion is not completely shared by other officers, who take more pessimistic attitudes. "How would you like to run a war depending on the French public telephone system for communications?" demanded one. Another pointed out that the French attitude on control of nuclear weapons forced USAF to bunch its units together on forward German fields within easy reach of the border. "We're sitting ducks," he added.

But in spite of problems that would arise in any organization so inherently complex, NATO continues to justify its existence. Since the formation of the North Atlantic Treaty Organization in

GERMAN developed Bolkow Cobra missile will be built in U. S. by Daystrom.

LOCKHEED F-104C. Many NATO nations chose it for modernizing their air forces

1948 the Soviet bloc has been contained in Europe The boundaries of that date have not been advanced a single inch farther west

This is the true value of NATO and its biggest continuing problem

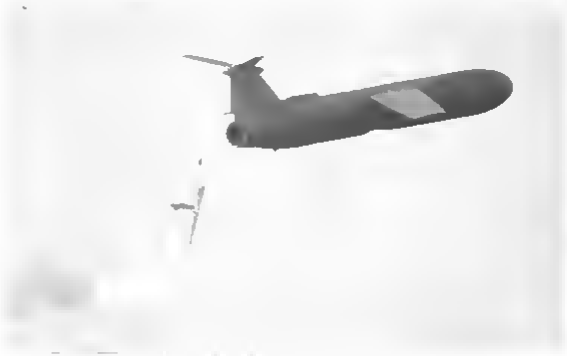
Politically and militarily, NATO is so complex that merely looking at it is mentally fatiguing The whole atmosphere seems designed to create confusion, and visitors to any headquarters are apt to go away believing everything is either all good or all bad It is like one type of engineering problem, if you choose your basic assumptions carefully, you can prove just about anything you want

The pessimist sees the alliance flounder ering because of de Gaulle's attitude, because the Greeks refuse to have IRBM bases on their territory, because of holes in the radar screen, and mostly because the whole command net is still based on the French telephone system

The optimist sees NATO increasing in strength because of improved weapons replacing aging American subsidies, because of a sprawling network of new airfields for dispersion, because of vastly improved integration of different nationals at staff levels, and mostly because forward scatter communications is replacing the French telephone system

But whether NATO looks good or bad, there is no contesting the fact that it is working The miracle of NATO is that it works at all

The alliance is an organization of 15 nations that have very little in



MARTIN TM-71 Mace air breathing missile will be bought by Germans.

CREW STATION MOCK-UP—static evaluation of display concepts.

COED CONSOLE—dynamic simulation of prototype man/machine interface.

COED/IBM 704 FACILITY—speed and flexibility for real time simulation of man/machine systems.

COED . . . computer operated electronic display

The airborne data processing system for the EAGLE missile concept uses advanced digital data handling complemented by the intelligence of the human operator. Coordinated transfer of data between man and machine is implemented with human-factored electronic display and control devices.

Balanced man and computer functions are assured in the development of the EAGLE electronic system through analysis and experimentation with realistic operational missions using the COED (Computer Operated Electronic Display) simulator. This simulation involves real-time programs for a large-scale digital computer which are integrated with cathode-ray-tube alpha-numeric displays and operator controls.

The COED system has been developed to provide a special facility for versatile and realistic simulations of the man-machine interface. It is a stepping stone in the Bendix program of *Intellectronics* where the ultimate goal is the machine synthesis of man's unique perceptual and intellectual faculties.

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Bendix Systems Division
ANN ARBOR, MICHIGAN

CANADIAN RCAF Golden Hawks formation in Canadair Sabres

common except an approach to a defensive strategy and signatures on impressive documents.

They speak 12 languages. Their lands stretch from the Arctic circle to the 36th parallel. Their forces vary from Luxembourg's single brigade to the United States' two and one-half million men under arms.

Their weapons run the gamut from horse cavalry to brand-new Mach 2 fighters.

All these weapons are spread along a gigantic arc of the free world's real estate that used to face the main threat from the East but which now flanks it. And although the nature of the threat has changed somewhat in detail, and has added a large number of possible variations on the theme, the basic concept of NATO remains the same.

NATO forces are Shield forces in the jargon of SHAPE headquarters. If there is a threat—either locally or on a global basis—NATO is supposed to meet it with enough available force to make the aggressor stop and reconsider. This "pause forcing" is a key concept in the overall strategy and is NATO's answer to the accidental border incident, the deliberate probe, or the all-out move.

Faced with reconsideration, the aggressor either decides to pull back his forces, or decides to go ahead in an all-out war. If he elects the latter, NATO strike forces are alerted and drive against their preselected targets. Backing them up comes the second major element, behind the Shield, the Sword of USAF's Strategic Air Command and RAF's Bomber Command.

"I feel okay about the Sword," said an officer, "but the Shield has a couple of holes in it."

Biggest of the holes was personally hacked out by President Charles de Gaulle of France by his attitude on the control of atomic weapons. This act alone might not have been so badly received had it not been coupled with the knowledge that France was footdrag-

RAYTHEON Hawk will be a joint manufacturing effort by NATO countries.

REPUBLIC F-105 Thunderchief under consideration by some NATO countries.

going across the board on its NATO commitments

France's strategic position squarely in the middle of the alliance and its potential as a supplier of large air, sea and land forces makes it one of the most important members of NATO But most of France's military effort has been devoted to the war in Algeria, which has dragged on for five years and which shows only faint signs of reaching some kind of conclusion

High ranking officers at NATO have been more than kind to the French in their trials Very little has been said publicly about the weakness of the French forces assigned to NATO Examples only two French divisions are with NATO out of one million men under arms No French-bought aircraft —Vautours and Super Mystères—fly under NATO commands French commanders disagree among themselves and with de Gaulle about the extent to which their NATO and national responsibilities conflict

There are signs that the situation may improve, and that the French may be willing to work out some program of joint control of atomic warheads for NATO operations If this happens, then the largest hole in the Shield would be closed.

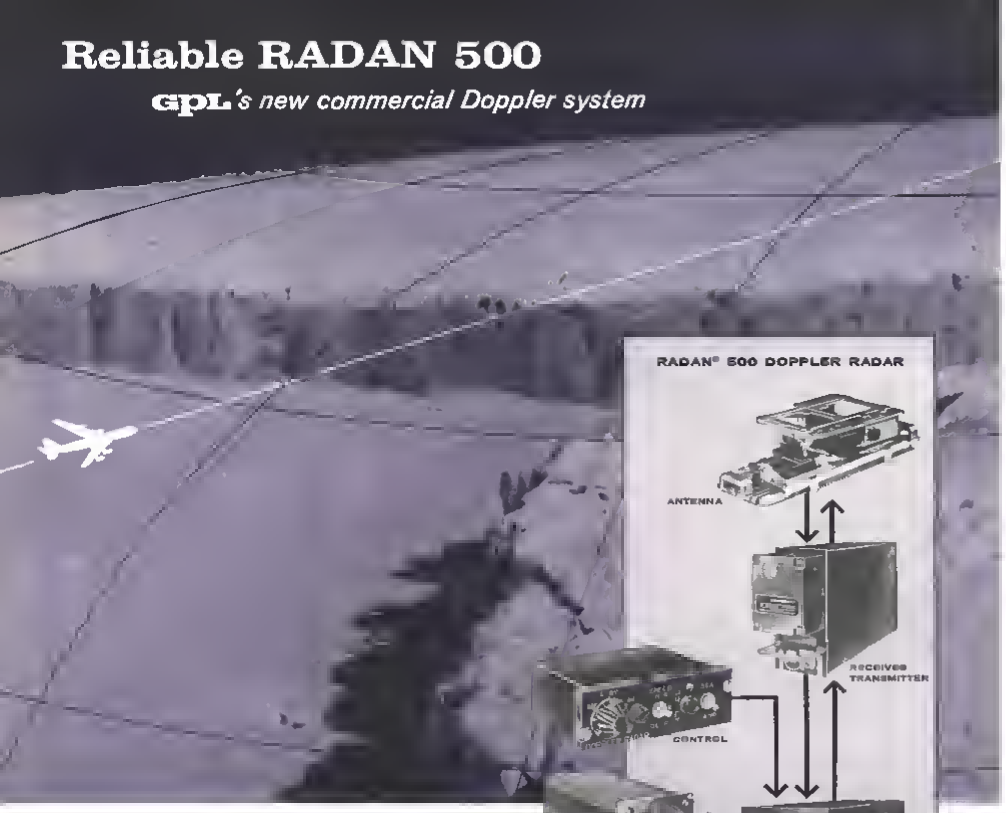
There is a host of smaller problems in NATO. Belgium has been hard hit financially by the cost of supporting its defense establishment A general study and revision of the country's military budget is under way and can only result in a lowering of its NATO commitment The much-publicized joint effort of the Belgians and Dutch to evaluate and select a new aircraft for their air forces evaporated in the heat of a unilateral decision by the Dutch to take the Lockheed F-104G Within a few weeks The Belgians followed suit reluctantly Their initial order for airplanes will be only 50 units, instead of enough to meet the real replacement needs of Belgian airpower

Standardization of equipment, which for long years was a disagreeable word at NATO headquarters, remains a bit improper in polite conversation At one time, there were high hopes among engineering officers in the Air Force, for example, that such common units as ground starters, drop tanks, fuel filler necks and the like, mostly having to do with pre-flight and post-flight operations, would be standardized within NATO air forces This is still a dream, although some progress has been made But the feeling is now that the tactical mobility once planned, which would

CANADAIR CL-41 trainer was developed for possible RCAF use

Reliable RADAN 500

GPL's new commercial Doppler system



RADAN 500 Doppler radar, GPL's all new ARINC system for airlines offers the reliability and longevity of service that only 13 years of direct Doppler experience can insure... reliability resulting from **flight-proven** designs based on 10 years of product improvement programs, service feedback on more than 1,500 operational GPL Doppler systems, and special attention to the design and maintenance philosophies of commercial airlines.

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have made such standardization mandatory, is too ambitious. Mobility will extend only to the borders of any country, at least for any sustained military operation.

Communications have always been one of the problems faced by NATO. Twelve languages are difficult to handle even under ideal conditions, so headquarters became officially bilingual. "That means the French speak English and the Americans speak English," cracked one Frenchman. But at the higher level, there has been the problem of obtaining an overall jam proof, sabotage-proof communications net to stretch from the farthest north stations of Norway to the extreme reaches of Turkey. Forward scatter techniques have been put to work, and last year the first link in an eventual NATO-long tropospheric system were forged. Orders were transmitted successfully from Norway to Naples and Izmir. Progress on this system has been close to schedule.

Future Growth

Brightest hope in NATO is Germany. The country is almost the perfect partner. Strategically located, wealthy, experienced in military organizations and the use of new weapons, eager to prove itself again, Germany is moving fast into a position of extreme strength. Within two years the Luftwaffe is scheduled to be the strongest single air force in the alliance. Its 660 Lockheed F-104G strike/interceptors and 232 Fiat G 91 fighter-bombers will be a formidable tactical weapon.

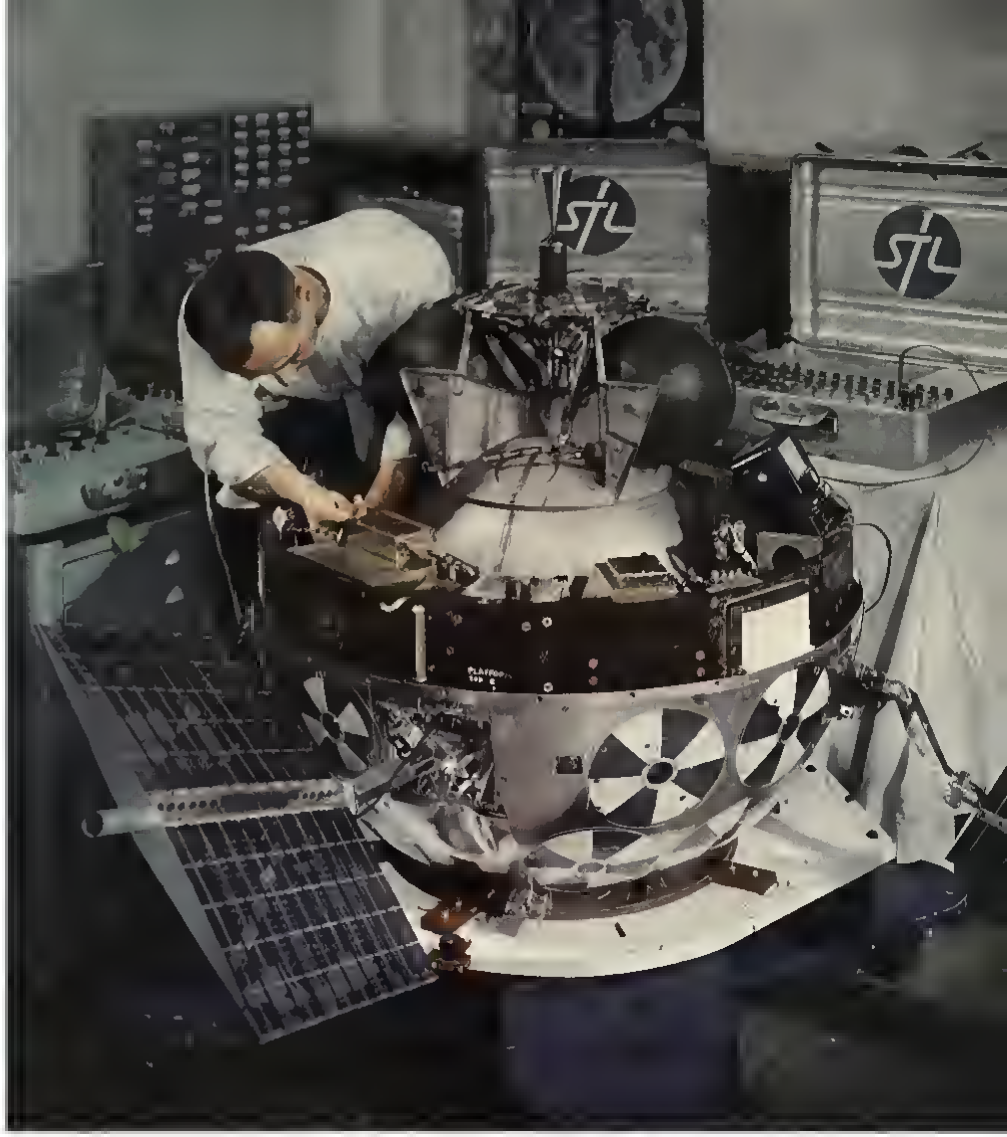
On the ground, the Wehrmacht will be armored, mobile and missile-armed along the lines of the U. S. Army's most modern units.

Meantime, German officers and men have been reporting for duty in increasing numbers at various headquarters. The gray uniforms of the new Luftwaffe, complete with the decorations of the old, are standard sights in the halls of Fontainebleau and Versailles.

Those military men who work together with the daily problems facing the combined commands have nothing but the highest respect for their German counterparts, and see in their numbers and capabilities a great addition to the strength of NATO.

Ten years ago the major problems of NATO seemed almost insoluble, national, political, linguistic and military differences were so marked that there were severe doubts that the organization would live to see its tenth birthday. It passed that mark two years ago, still growing.

Today NATO is stronger than ever before. It is a relative strength, and is not what the planners expected or now want. But the results are plain. NATO is strong enough to hold the line it was created to hold.



Atlas Able IV satellite payload in preparation at Space Technology Laboratories.

Space Technology

U. S. Space Effort Matures in Dual Pattern

By Craig Lewis

Washington—Basic operational, technical and scientific pattern has emerged from the chaos of early U. S. efforts in the space age, and within this pattern the nation is moving along separate civil and military paths into space. The mandate for building U. S. prestige in space exploration is now clearly in civilian hands.

National Aeronautics and Space Administration has emerged from the now-muted struggle for space dominance with the lion's share of support and missions, and the military contenders are confined to strictly military systems and missions. Although there is some dissatisfaction with the split civil-military concept, the main burden of the U. S. effort now falls on NASA as it moves ahead with its national space program.

NASA's dominant role evolved over the past year as the once-powerful Advanced Research Projects Agency was cut back to an advanced research agency and as major systems were transferred to the space agency. Crowning move was the shift last fall of the Saturn booster and the Army Ballistic Missile Agency's Development Operations Division to NASA.

Fund Requests

Along with the sharp increases in facilities, personnel and missions, NASA's budget rises nearly to $1 billion for the next fiscal year. A $113 million supplemental request has been added to the agency's original $802 million request for Fiscal 1961. Congress appropriated $500 million for the space agency this year, and NASA is asking for another $23 million this year largely to keep Project Mercury on schedule.

The greatest part of the increase in the Fiscal 1961 budget is slated for the Saturn program, which will absorb about a quarter of the total spending authority requested for the period. Actual spending on NASA programs generally will rise substantially in the next fiscal year as the systems and services ordered in the agency's early months are delivered in increasing volume.

Although President Eisenhower officially denies that the U. S. is in a race with the Soviet Union, the fact is widely accepted. The Administration has made at least a tacit admission of this fact by authorizing a significant acceleration of the super booster program, the single long-term U. S. program with real promise of surpassing Soviet achievements when its launch systems are ready for service.

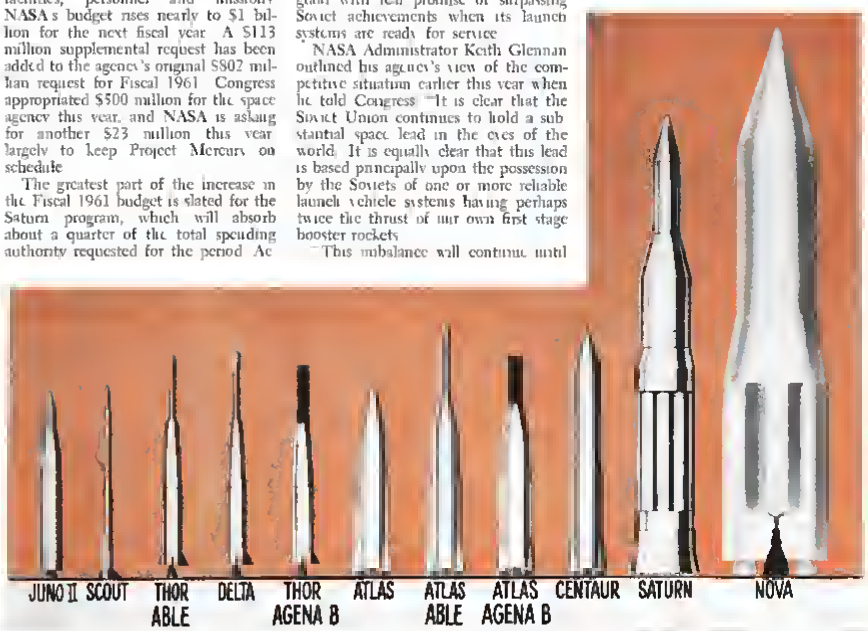
NASA Administrator Keith Glennan outlined his agency's view of the competitive situation earlier this year when he told Congress: "It is clear that the Soviet Union continues to hold a substantial space lead in the eyes of the world. It is equally clear that this lead is based principally upon the possession by the Soviets of one or more reliable launch vehicle systems having perhaps twice the thrust of our own first stage booster rockets.

"This imbalance will continue until we have achieved a launch vehicle system that fully exploits the thrust of the Atlas through the construction and use of properly proportioned new upper stages, or until we have achieved a launch vehicle system which is based on a much more powerful first stage rocket—or both." Anticipating further Russian gains, Glennan said the U. S. will most likely have to wait for the Saturn booster before it can hope for space superiority.

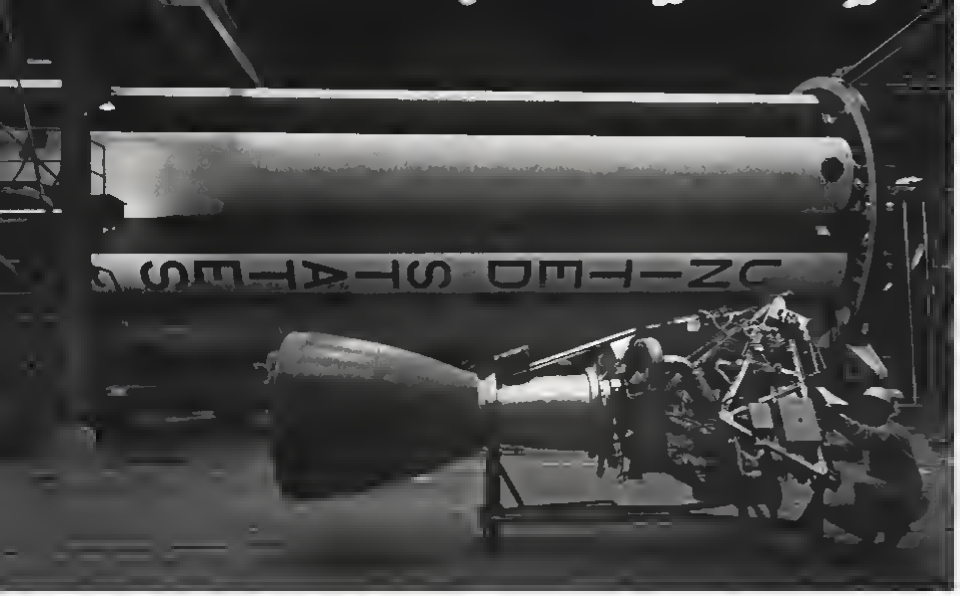
'Equal Capability'

"In no other aspect of the space business do we appear to lag the Soviet Union," he said. "In all other aspects, it is my opinion that we have an equal capability and that we have published more significant scientific results, more fully and more promptly than they."

Mating of Atlas with efficient upper stages will permit the U. S. to match current Soviet space achievements, but since the Soviets will undoubtedly be moving ahead while these Atlas-based vehicles are still under development, the big jump to Saturn with its 1.5



EXISTING AND PLANNED U. S. SPACE VEHICLES



SATURN FIRST STAGE WITH ONE OF ITS 8 H-1 ENGINES

million lb thrust first stage will probably offer the first chance of parity with the Russians

Best prospect for a breakthrough into a new area of space flight using the Atlas lies in Project Mercury, a program which shares highest national priority with Saturn. Despite schedule slippage in various parts of the program, Mercury is moving forward at an acceptable pace and still aims for an initial manned flight before the end of next year.

Mercury Cost

Cost estimates of the Mercury program are now running $350 million, and the cost could easily mount to $400 million before the first manned flight is made. This is double the original cost estimate, and it illustrates one of the problems NASA has faced in its initial 18 months experience with establishing a long range program while trying to show some short range results. Lack of experience led to too much optimism in scheduling and estimating costs of many projects. The resulting higher costs and delays have strained the already tight budget and tended to stretch out a number of testing and launching schedules.

With Mercury, the inclination is toward spending more money rather than accepting delays. Mercury pilots are well along in their program of training and engineering participation, and McDonnell Aircraft Corp. is delivering the first of the operational capsules. One capsule will be tested with a Little Joe booster, then further qualification flights will begin this summer with Redstone boosters. Latter part of the Redstone series is scheduled to include the first manned suborbital flight.

Atlas will also be used in a parallel series of unmanned suborbital flights ranging to distances of 4,000 mi. When the ballistic flight tests are completed, the capsule will go into orbit first carrying instruments and then with a primate as a specimen for checking its systems and equipment. NASA will have completed the 18 station Mercury tracking network, which has been expanded to provide nearly continuous monitoring of the capsule in orbit, and with all the equipment proved, the first man should go into an orbital flight before the end of next year.

NASA is also exploring elements of manned space flight in the X-15 program, a cooperative effort with the Air Force and Navy. Flights with the X-15 will provide operational data on controlled re-entry with a winged vehicle. NASA is now receiving its first X-15 from North American Aviation and will get another two later this year.

The Dyna-Soar program, which is to be a NASA-Air Force program, is designed to carry flight development beyond the suborbital regime of the X-15 to orbital flight and controlled re-entry. The program has long suffered from indecision. Although an industry team has been chosen to develop the Dyna Soar vehicle and launch system, the ultimate fate of the project is unsettled.

Shining top priority with Mercury is the newly accelerated Saturn program. After limping along in a semi-orphan status for a year, Saturn found a home when it was transferred from the Advanced Research Projects Agency to NASA and when the President decided to mount a high priority effort behind the super booster program. This effort is now designed to have a Saturn vehicle ready by 1964 and to accelerate development of the 1.5 million lb F-1 single chamber engine intended for the Nova vehicle.

Hydrogen Stages

NASA is casting its lot with liquid hydrogen to produce a high thrust Saturn vehicle. First stage uses conventional Rocketdyne H-1 liquid rocket engines, but all the upper stages will burn hydrogen. Initially, Saturn will use two upper stages powered by engines based on the Pratt & Whitney XLR-115 hydrogen engine now being developed for the Centaur vehicle. A competition is now in progress for a new 200,000 lb thrust hydrogen engine which, in clusters of two and four, will be added to the Saturn vehicle staging and produce significant increases in payload capacity.

Eight-engine clustered Saturn first stage is scheduled for static test shortly, and this first stage, which is to be recoverable, will be test flown about a year later. Development testing of the Nova vehicle with its F-1 engine is now scheduled to start in 1968.

As the Saturn is developed, NASA is weeding out the welter of launch vehicles, patched together largely from available military missiles, which have served since Sputnik I triggered a pell mell expansion of the space program beyond the modest Project Vanguard concept. Role of the Juno II, Thor-Able and Atlas-Able boosters will be finished this year.

NASA wants to reduce the number of booster systems in the program to increase reliability through more frequent use of each of a limited number of systems. Thor and Atlas will be the first stages used until Saturn is ready, although the role of Thor is likely to diminish even before then. These two boosters will be used in conjunction with the Agena and Centaur upper stages when they are ready next year.

Delta Vehicle

Thor will also be used in the Delta vehicle scheduled for a dozen launches over the next two years. First test of Delta is expected soon. Scout completes the NASA booster family, and it also is to make its first flight soon. This four stage solid propellant vehicle will serve through the coming decade as a relatively cheap utility launch vehicle.

Agena is a new entry in the family; it replaced Vega when that program was canceled in December. NASA dropped the Vega concept when it became apparent that the ARPA-developed Agena upper stage could perform some of its missions and that Centaur would be available at about the same time as Vega to do the rest. Agena-B on Thor and Atlas and the hydrogen-fueled Centaur on Atlas will be the nation's workhorse upper stages after they become available next year.

NASA is working with the Atomic Energy Commission to develop a nuclear rocket through Project Rover. AEC is developing the reactor, and NASA supplies the non-nuclear components and the hydrogen propellant. First tests of a crude sort of prototype called Kiwi-A were made last summer. Development of a turbopump for the Rover rocket is under way, and NASA soon will initiate development of a liquid hydrogen-cooled rocket nozzle for the test program.

The agency also has design studies under way to determine the best way to flight test the nuclear rocket, and industry will be asked to help in this evaluation.

For the long term, low thrust requirements of interorbital and interplanetary travel, NASA is working on electrical propulsion, mostly in the ion engine field. Considerable work has been done at Lewis Research Center, and the agency is now awarding research and development contracts to industry.

Systems to generate electrical power both for propulsion and for auxiliary power are also under development. Prototype systems using radioisotope and reactor power sources have been developed, and NASA is now awarding a contract for a Snap VIII system which will use a nuclear reactor to develop 30 kw of power through a turbogenerator system. This will be the first system that can produce both auxiliary and useful propulsive power.

Solar power supplies are another study area. Such a system might concentrate solar heat to boil a liquid metal and drive a turboelectric system. NASA is asking for proposals on the 3 kw. Sunflower I solar power system which will supply power for the payloads launched by the Centaur and Saturn vehicles.

With boosters available and through pioneering work in using solar cells to maintain space power supplies, NASA counted a number of successes during the past year. Although not on the spectacular scale of Soviet's, these contributed solid scientific advances, especially in the study of radiation fields surrounding the earth. Sounding rockets also made their contributions, notably in the study of wind shear and velocities at altitudes of 70-100 mi. and above.

Early in 1959, Vanguard II was put into orbit with photocells for measuring cloud cover. Wobbling has made data difficult to interpret, and analysis is still going on. A few weeks later, Pioneer IV was fired into a sun orbit and tracked for a distance of 407,000 mi. from earth, providing valuable radiation data. Following this, there were three straight failures when Vanguards launched in April and June and a Juno II vehicle launched in July failed to put satellites into orbit.

Explorer VI, the first satellite basically initiated by NASA, was launched into a highly elliptical orbit by a Thor-Able vehicle in August. This complex payload made the first use of solar cells in its four paddlewheels, and it broadcast data on 14 different experiments until its transmitter quit two months later. At about the same time, a second attempt to launch a Beacon inflatable sphere with a Juno II for air density measurements failed.

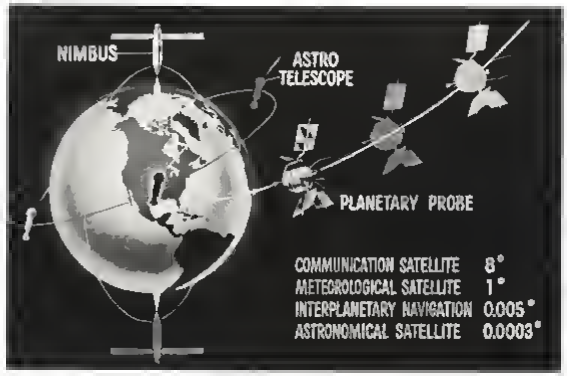
A month later, Vanguard III, last in the series, went into orbit. In October, Explorer VII was put into orbit successfully in a repeat of the July Juno II attempt. This satellite is still broadcasting.

Large scale flight testing of the Mercury capsule began with a Big Joe launch in September. The Atlas-boosted boilerplate capsule didn't run through the full flight pattern schedule, but it was successful enough to warrant calling off a second Big Joe test. First Little Joe test attempt aborted in August because of premature escape rocket ignition, and the test series was subsequently launched in October. Since then, there have been four Little Joe tests, including two with monkeys, and the program has been generally successful.

Greatest public disappointment over the past year was the repeated failure of the Atlas-Able IV project to put a payload in orbit around the moon. First vehicle was destroyed during static firing of its Atlas engines. A surplus Atlas from the canceled Big Joe shot was substituted, but the attempted launch failed in November when the upper stage fairing fell away prematurely and the payload was torn from the vehicle.

Lack of backup boosters was highlighted in the Atlas-Able situation, and it became a point of controversy. It was also a significant sign of the tight

MERCURY CAPSULE



PLANNED NASA SPACE PROBES

cost and scheduling framework most of the space program works under. The Atlas-Able lunar orbiter will be launched again this summer and this time there will be a backup vehicle. But generally, NASA doesn't feel it can afford backups, and when a launch fails its payload probably will be shifted to the next vehicle in the schedule. The whole schedule of payloads in a series can thus be delayed one launch with every failure.

USAF in Space

While NASA has been developing a civil-oriented space program, the services have been developing a number of space projects in line with their individual missions. As ARPA faded quickly from its role as the military space agency last fall, the Air Force emerged as the dominant service in the space field. USAF has all military boosters under its control, along with the reconnaissance and early warning satellite programs.

Navy inherited navigation satellite responsibility from ARPA and Army the communication satellite. With these roles finally assigned by the Defense Department, the rivalry of the past has been dimmed, but the Army and Navy are still pushing hard for bigger space roles. Their efforts are bent toward establishment of a joint space command to handle all military space programs under revolving control of the three services.

The services are also continuing a campaign for a bigger military role in the national space effort. They maintain that space is a critical field for military operations and that military needs in space should have top priority. There has been a sporadic campaign in military and congressional circles for a single civil-military space agency to handle the space program in the same way AEC handles the atomic energy program. The President strongly opposes this concept, and there is little present chance for it.

Air Force has been successful with its Discoverer program, and it was the success of the Agena second stage in this program that led NASA to substitute it for Vega. Discoverer satellite has successfully gone into orbit in six of 10 attempts, although efforts to recover a re-entry capsule from the satellite have all failed. This vehicle will be used to launch the Samos and Midas satellites and recovery of data capsules is an important element of reconnaissance satellite systems.

Midas infrared early warning satellite is now entering its flight test stage, but Samos is not yet ready for flight. Navy failed last September in its first attempt to put its Transit navigation satellite test vehicle in orbit, but a second attempt is scheduled next month. Army plans to launch its first Courier communications satellite test vehicle this month.

NASA is developing a program of international cooperation that will result in U.S. launches of satellites of other nations. Agreements have been reached to launch the first of three British satellites and to launch a Canadian satellite, and discussions are being conducted with Australia, Argentina, Belgium, France, Japan, Israel, Italy, New Zealand, Sweden and West Germany.

Efforts have been made to establish cooperative ventures with the Soviet Union with generally negative results. The Russians approve of the principle of cooperation but they want to work through the United Nations space conference to be held this year. They have not responded to a U.S. offer of tracking facilities for use in conjunction with their manned space flight program.

NASA is also involved in negotia-

tions for tracking sites. Arrangements are being discussed for expanding the Minitrack system to Newfoundland and England, and the agency is negotiating sites in Australia, Bermuda, the Canary Islands, Canton Island, Mexico, Nigeria and Zanzibar for the Mercury tracking network. For deep space probes, an 85 ft. steerable tracking dish is under construction at Woomera, Australia, and a second antenna is scheduled for southern Africa.

NASA plans to accelerate its launching pace within the pattern that has developed over the past year. Mercury test flights will increase in number and scope, and sounding rocket activity is scheduled to rise to the level of 100-120 firings a year. Satellites and space probes will be confined to the capabilities of present boosters in the near future, but frequency is scheduled to increase and more ambitious plans are now being laid for the Atlas-Agena and Atlas-Centaur vehicles when they are available next year.

Launches scheduled for this spring include the Thor-Able IV paddlewheel probe which was once scheduled for a mission last spring and which was postponed again in December. It will be fired along a path that will intersect the orbital path of Venus, and it will test radio communications in deep space. NASA will also launch the Project Echo 100 ft. inflatable sphere into orbit this spring to act as a reflector in radio communications tests between New Jersey and California.

Meteorological satellite program is scheduled to get under way at about the same time with a Thor-Able launch of Tiros I. Tiros I will have two television camera systems for cloud cover photography and a later version, Tiros II, will also have scanning and non-scanning infrared detection systems. Tiros II will be launched next summer with a Thor-Delta vehicle.

By 1962, NASA expects to be able to launch a Nimbus meteorological satellite into a polar orbit with a Thor-Agena B. This advanced satellite will have the advantage of being earth-oriented and will be equipped with television and infrared systems, with spectrometer and radar equipment planned for later versions.

Juno II program will be completed this year with the launching of four satellites. First one will be launched before July and will conduct radiation belt studies. Subsequent satellites will explore ionosphere properties and gamma and cosmic rays, and the last one will serve as an ionosphere beacon.

Plans for Thor-Delta include a solar spectroscope satellite before the end of the year, a satellite to make radiation belt studies early next year and three satellite launches during Fiscal 1962, including the Canadian topside

sounder. The last three will be launched into orbits across polar regions.

Scout is expected to become available this year. After development testing, Scout will be used for space probe missions to altitudes ranging from 5,000 to 10,000 mi.

Ionospheric Study

A flight to study the ionosphere structure is slated for late this year, and a similar launch is scheduled for early next year along with a nuclear emulsion recovery shot. A study of outer atmosphere winds will be conducted in Fiscal 1962.

Scout is to be ready for routine satellite launches in Fiscal 1962 and most orbits will be across polar areas. Of four shots in Fiscal 1962, two will launch satellites produced by other countries and the other two will conduct polar ionosphere and polar radiation studies. An international shot and a study of the polar atmosphere structure are scheduled for Fiscal 1963.

Agena Payloads

When the Agena vehicles become available in Fiscal 1962, they will be able to put 1,000 lb. payloads in orbit. A Thor-Agena will put a satellite into a low polar orbit for geophysical observations, and later an Atlas-Agena will launch a satellite into a highly eccentric polar orbit for similar studies. A Thor-Agena will launch a satellite into an orbit with a low inclination to the equator during Fiscal 1963 to study sun-earth relationships and in the same period an Atlas-Agena will put a satellite weighing several tons into a similar orbit to serve as an astronomical observatory.

In addition to the Thor-Able IV space probe, a Thor-Delta probe will be launched by the end of the year for interplanetary plasma and field studies, and two Atlas-Able lunar orbiter vehicles will be launched in the summer and fall.

Next year, Atlas-Agena will be available, and the first two Atlas-Agena probes will be used to measure the interplanetary environment and to develop technology necessary for more advanced missions.

Moon Studies

NASA has scheduled three Atlas-Agena vehicles during Fiscal 1962 which will conduct studies of surface properties of the moon, including television scanning and the landing of instruments.

During Fiscal 1963, Venus and Mars will be in favorable positions for payloads to be launched toward them. Atlas-Centaur is to be ready in this period, and it will be used for these missions.

USSR Hatches More Space 'Spectaculars'

By Evert Clark

Washington—Soviet Russia is about to begin a new chapter in the conquest of space that will assure her leadership over the U. S. in this field for some years to come.

The primary advantage that will provide Russia with superiority in this second round is exactly the same one that gave her leadership in the first place—superior propulsive power.

The new rocket tested recently in the Pacific Ocean is reported to be able to launch earth satellites weighing several tons, and to send equally impressive payloads to the moon and planets. So far there is no reason to doubt the Russian claims.

After Russia first startled the Western world with Sputnik I two and one half years ago, the reasons for her unexpected capability soon became obvious—an organized program, financially and politically supported, and a large launching vehicle.

Silver Lining

But in basic scientific and engineering capability Russia still was widely believed to be inferior to the U. S., and considerable hope was placed in the ability of U. S. science, technology and industry to make up for the lack of propulsion through skills such as miniaturization of electronic payload components, ingenuity in vehicle design, etc.

There also was a tendency early in the space age to assume that Russia would base her efforts on the use of the same vehicle that launched the first Sputniks, at least for a long enough period that the U. S. might catch up in vehicle technology.

The belief that ingenuity and quality of scientific effort might be substituted for vehicle power was furthered when the U. S. Explorer satellites discovered the Van Allen radiation belts after Sputnik II had partially detected them but Soviet scientists had failed to recognize their importance.

Even the launching of the ton-and-a-half cosmic laboratory Sputnik III did not deter U. S. hopes that sending a probe to the vicinity of the moon might provide the scientifically useful yet spectacular achievement that would raise U. S. prestige in the world.

Four unsuccessful attempts were made to send U. S. probes either into a lunar orbit or past the moon between the time Russia launched Sputnik III and the time she did what the U. S. had failed to do by sending Mechta within two diameters of the moon.

The success of the United States' own moon rocket, Pioneer IV, again showed that a shrewdly designed small package—13 lb.—could be made to do useful things, and again raised hopes that Russia might be outdone scientifically, if not in terms of sheer weight sent into space.

In the few months' hiatus that followed before the next Soviet "spectacular" occurred, the U. S. successfully launched a number of scientifically significant satellites probing the radiation belts further and obtaining the maximum results that could be expected with the limited booster vehicles at its disposal.

The effect of this on world opinion—which is a primary goal of the entire Soviet space program from the Russian government's point of view—was favorable to the U. S. As George V. Allen, director of the U. S. Information Agency, described it recently:

During the 18-month period following the first Sputnik, our reports showed that the U. S. steadily regained prestige. At the same time the prestige that accompanied Soviet achievements also continued to increase, so our regaining of stature did not approach the commanding position that we had enjoyed before Sputnik I."

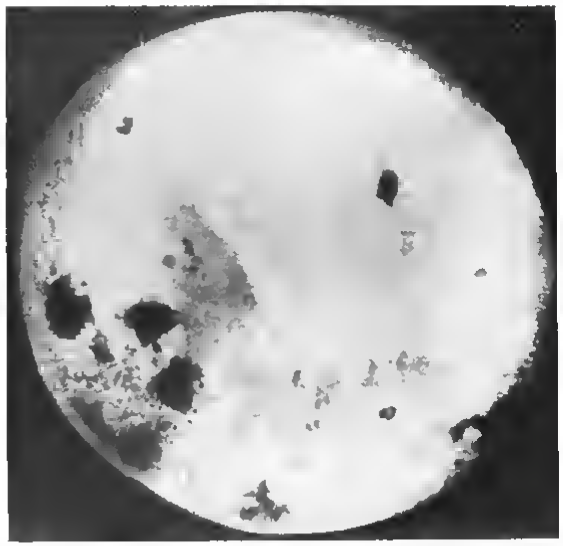
"Furthermore," Allen said, "our failure to equal Soviet accomplishment in terms the world sees as important—success in placing very large payloads in orbit—made the Soviet program even more impressive."

U. S.-Soviet Seesaw

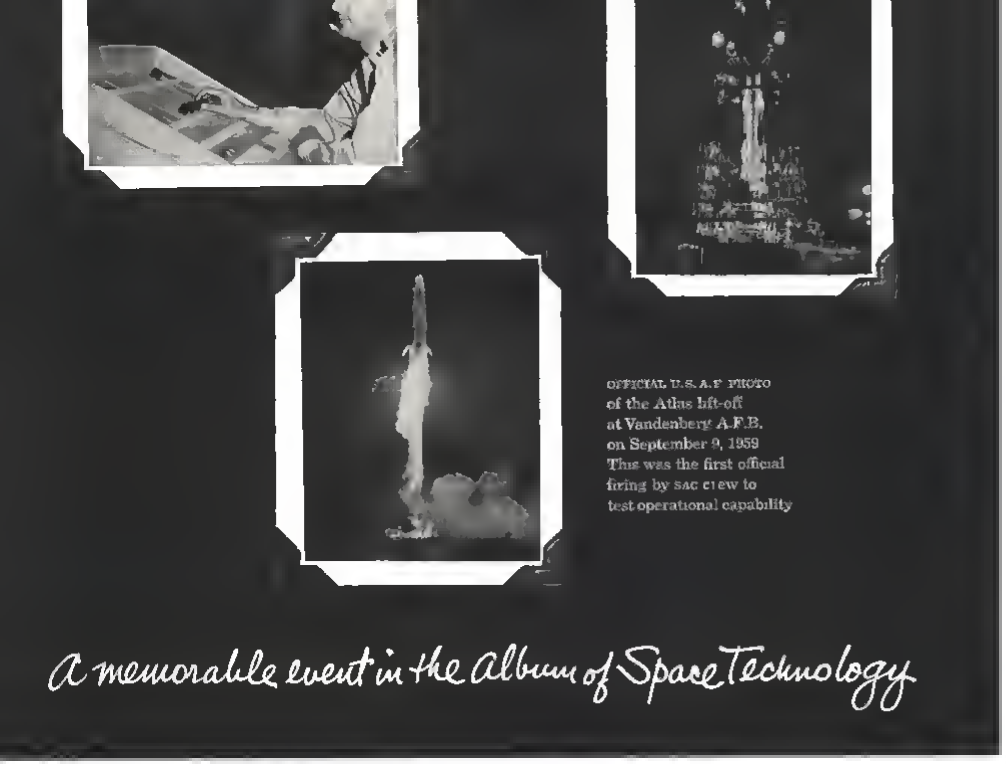
"For a period of many months, the prevailing world opinion seemed to anticipate a kind of seesaw, with first the U. S. and then the Soviet Union accomplishing some noteworthy activity. This was accompanied by some hopeful notes that the U. S. would overtake the Soviets in payload weight, guidance accuracy and so on."

During this period the U. S. had hoped to launch a Thor-Able and an Atlas-Able to the vicinity of Venus. When the time for a favorable launching passed without either probe being fully ready for flight, the mission of the Atlas-Able was shifted to that of a lunar orbiter—a feat the Russians had not tried, or at least had not succeeded in doing.

Last September, however, the long wait for the next Soviet space event was ended when Russia successfully unpacked a payload and a carrier rocket on



RUSSIAN PHOTO OF MOON'S FAR SIDE



OFFICIAL U.S.A.F. PHOTO
of the Atlas lift-off
at Vandenberg A.F.B.
on September 9, 1959
This was the first official
firing by sac crew to
test operational capability

A memorable event in the Album of Space Technology

Many significant achievements will be added to those already recorded in the chronicles of military and scientific space technology. Many important milestones in the conquest of space will be passed. None, however, will surpass the realization of America's operational capability in Intercontinental Ballistic Missiles. The threshold of this phase of our national defense was passed during early autumn in 1959, with the historic launch of an Atlas by a Strategic Air Command crew at Vandenberg Air Force Base, California. Measured by any standard no event could have been more timely . . . more rewarding.

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All have worked in concert with vigor and dedication to the objective of providing the nation with this fundamental addition to its defense capability.

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the moon. A week later the Atlas-Able probe blew up the pad following a static test of its first stage engine.

No backup vehicle existed for the U. S. probe. An Atlas was borrowed from the Mercury man-in-space program and another Atlas-Able probe was fashioned hastily in the hope that the U. S. still might orbit the moon before Russia did.

But the Soviets followed their lunar impact three weeks later by passing behind the moon, photographing its unseen side, transmitting the photos over distances up to 274,000 mi. and sending the photo satellite into a vastly elongated earth-lunar orbit.

The U. S. followed this on Thanksgiving Day with the launching of the second Atlas-Able, which only served to accentuate the Soviet success when its upper portions disintegrated after a few seconds of flight, aborting the mission.

The impact of this was described by George Allen to the House Science and Astronautics Committee this way:

"Then came the two dramatic and successful Soviet moon shots followed by the failure of our own. As a consequence of these events, the seesaw seems to have tipped solidly in the Soviet direction, in world opinion.

"Today, although we continue to see the hope expressed abroad that the U. S. will catch up, we also see growing doubt that this is likely during the next five or even 10 years."

Nine Months Late

U. S. attempts to launch the Thor-Able Venus probe now have slipped to the point that it will be launched almost three-quarters of a year behind its original target date.

The fact that the U. S. has successfully launched 13 satellites and has learned much from its three successful or partially successful space probes has done little to tip the seesaw back toward the American side.

In addition to the problems these delays have caused, another factor has become increasingly clear—that the Soviets are not merely hurling ton after ton of useless weight into orbit.

As these two facts—that there is indeed a race for prestige with the U. S. running a poor second, and that Russia has great scientific as well as technological competence—have forced themselves into public consciousness month after month, the grim reality of the U. S. situation finally has begun to be accepted even in the most optimistic and conservative circles.

A comparison of past U. S. and Soviet efforts, done recently for the National Aeronautics and Space Administration by its assistant director for space sciences, Dr. Homer E. Newell, Jr., drew these conclusions:

● ". . . U. S. and the USSR appear to be at about the same stage of advancement in upper air research.

● ". . . U. S. and the USSR seem to be at about the same stage of advancement in studies of the earth's environs where satellite techniques are adequate for making the necessary observations. In fact it may be that in this regard the U. S. has the slight edge. The big advantage the Soviets have in attacking these problems lies in their greater payload capacity. On the other hand, the U. S. has launched many more satellites than the Soviet Union.

● "In the deep space probe work the USSR has definitely taken the lead. This is directly attributable to their clear lead in vehicle technology."

As for problems currently under attack, Newell's comparative study showed "fairly clearly that the U. S. and USSR scientists are at about equal stages of advancement."

"As groups," Newell said, "they undoubtedly have comparable competencies and understandings of the significant problems that ought to be tackled. Their instrumentations are roughly equivalent, although the U. S. may have a slight edge here as indicated by the fact that the USSR quite often simply copies U. S. equipment for its own instrumentation.

Payload Advantage

"The conclusion follows then that the side that has the more advanced technology in the way of payload capabilities, guidance, etc., will have the distinct edge and by virtue of the increased flexibility and capabilities provided by the more advanced technology, will forge steadily ahead.

"Thus one may predict a time lead in vehicle technology will be transformed into a corresponding time lead in the exploration and investigation of outer space."

This amounts to a statement that Russian and U. S. scientists are equal but the Russians are more equal because of their "lead in vehicle technology"—and this conclusion was reached before the advent of, and presumably without advance knowledge of the powerful new vehicle that will carry on the second generation of Russian experiments.

Russian appreciation of the importance of the time factor in this exploration has been expressed by Prof. Anatoli A. Blagonravov, who is a general of artillery as well as apparent head of the Soviet space program.

"It is easy to see that precisely the time element is the decisive factor which should be grasped in the competition with the capitalist countries in the field of technology."

Time even more than the possible inadequacy of organizational effort or financial support, is on the side of the Russians and against the U. S. Before

the appearance of the new Soviet booster it was hoped that the introduction of the Atlas plus suitable upper stages might in about two years, give the U S the weight-in orbit capability now enjoyed by the Soviets

But the indications are that the new Soviet vehicle may well be in a weight lifting class with the U S Saturn super booster due to be ready for missions in 1964 The Soviet rocket apparently is almost ready for operational use The first Saturn, therefore, will be approximately four years behind in time

Many possibilities will be opened by this new vehicle, according to Soviet scientists Among those they have discussed as if they were definite goals for the near future are

• Manned space flight

There have been a number of indications that this will be attempted in the spring of this year Estimates by U S observers of how it might be done include placing of a one-man or two-man capsule in orbit around the earth, a two-man vehicle sent into a circumlunar orbit and returned to earth, possible Landing of two manned, returnable rockets on the moon, so that if one is damaged the second could be used for the return trip

Likely Steps

Only the first two possibilities—the earth orbiters—are considered likely as first steps, and it is believed likely that the more ambitious feats will require a rocket even larger than the one now in tests But Russian scientists have pointed out that they approach manned space flight as they do space exploration generally—taking large steps only, and attempting a new experiment only after its chances of success appear to be very great Specifically in the manned program and also generally the pattern has been to do experiments that are technically and scientifically sound and not to repeat experiments

Another indicator that manned space flight is near is the warning by Prof Georgiy Pokrovskiy, writing last month in the Russian magazine Questions of Philosophy, that the present level of science and technology does not yet make it possible to avoid some harm to the health of man in space travel" This is believed the first statement in many months by a Russian scientist that presented a negative side to the safety question Pokrovskiy went on to say that contemporary science makes it possible to expect that effective means will be found in the near future to "shield man against radiation"

The risk involved in the first landings on the moon or other planets and the return to earth also were mentioned by Pokrovskiy He said the probability of disaster compared with aviation is no greater than for ordinary test pilots

• Heavy earth satellites

These include an orbiting astronomical observatory, weather and navigation satellites, and eventually worldwide television relay stations, according to Soviet commentaries They are expected to weigh several tons

• Lunar observatories

There is good reason to believe that powered, automatic tankettes, capable of crawling over the lunar surface and relaying their findings to earth by radio and television will be placed on the surface of the moon in the near future These tankettes have been discussed in open literature since 1955 and have been discussed again in connection with the recent Pacific tests

TV, Radio Uses

Last month, Pokrovskiy said the paramount task at present is "to perfect the methods of man's contact with outer space through various media television and radio relay of aural and tactile sensations are about to be tapped for space exploration"

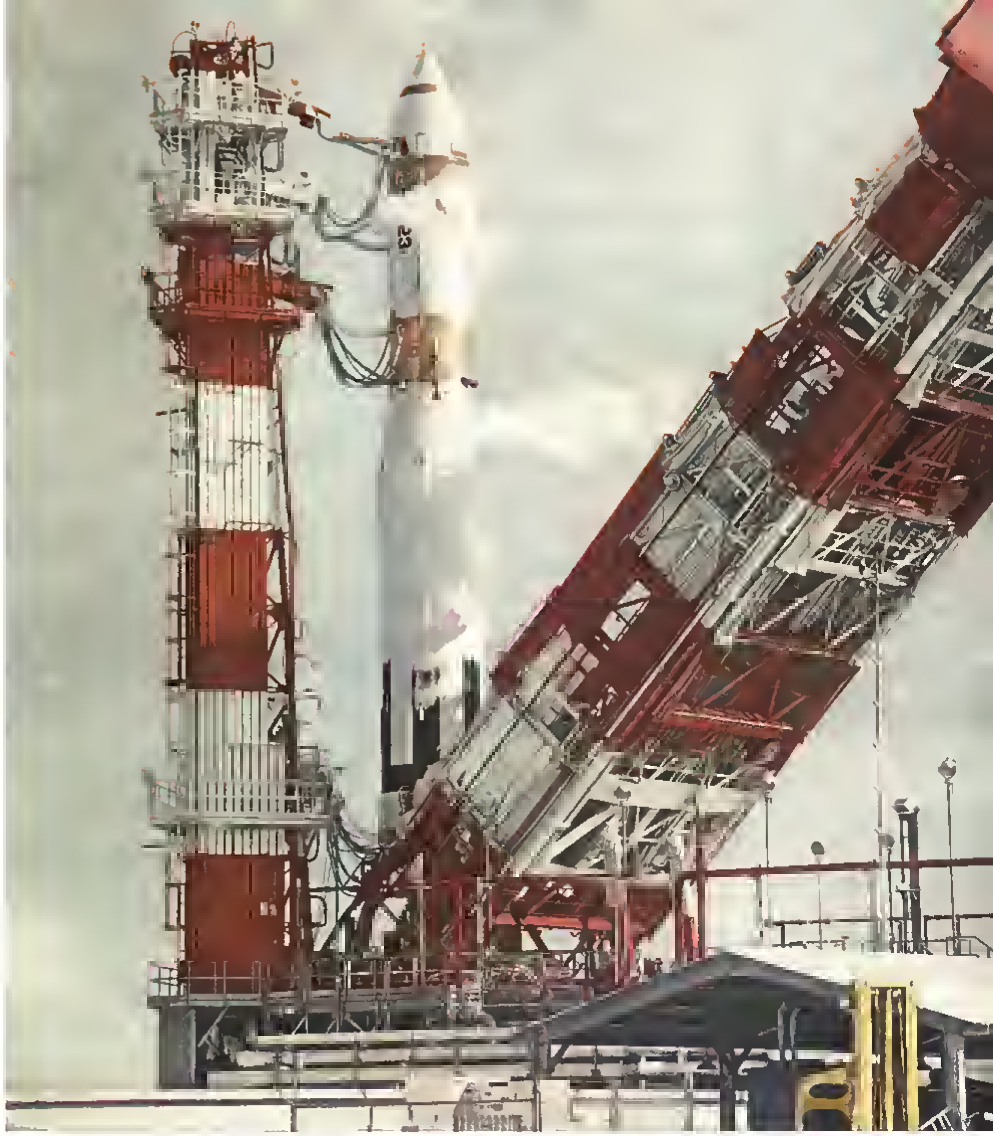
A Czechoslovakian astronomer Dr Boris Valnicek writing in the Czechoslovak People's Party daily, Lidova Demokracie, also said in analyzing the Pacific tests that it will be possible to land an automatic station (on the moon) which would measure the magnetic field, solar radiation, radioactivity and possibly even the structure of the surface of the moon"

• Planetary probes

One of the latest to write on the likelihood of attempts to probe the planets is Prof Arn Shternfeld Timetable for a possible launching to Mars is "from the last days of September to the beginning of October 1960," he said Flight to Venus might be made in November of this year, "but to achieve a flight to Venus precisely in that month a too powerful rocket would be needed," he said "A relatively lesser speed and thus an engine of lesser power, will be needed in the case of sending a rocket to Venus in December, 1960" Other Soviet scientists have spoken of photographing the planets both in black and white and color and in landing automatic laboratories there to seek solution of one of the mysteries of the world—the existence of life on other planets."

Blagonravov told delegates to the recent COSPAR meeting in France (AW Jan 25 p 32) that the next step in Russia's space program was a broad investigation of cosmic radiation in preparation for manned space flight This includes sending plants and highly organized living beings into space in a series of satellites he said

He also said study of the moon and planets will continue The implication is that all these studies will be done simultaneously



Martin Titan C intercontinental ballistic missile on pad at Cape Canaveral, Fla.

Missiles

Missile Grows As Weapon, Political Issue

By Russell Hawkes

Reluctantly, most U. S. officials are admitting that 1960 is opening an era of Soviet missile superiority in quantity if not in quality, though the Eisenhower Administration is minimizing or denying that this will have a decisive effect on the military balance of power.

Influence of the missile is spreading not only in international and U. S. domestic politics—in the latter the "missile gap" is likely to become a major presidential campaign issue—but in military strategy with the issuance of long range ballistic missiles to tactical units of both Russian and Western forces.

Administration of the U. S. missile program presents a confused picture of multiple lines of authority and uncertain relationships to the space program, but missile technology itself continues to progress.

Individual Programs

A missile-by-missile progress check reveals:

• **USAF Minuteman** three-stage solid propellant ICBM. At least five boiler plate missiles have been fired from underground silos in proving tests at Edwards AFB since Sept. 15, 1959. Major subcontracts have been let for launch control communications and a mobile base system. In 1960, an assembly and recycle facility will be constructed at Hill AFB.

• **USAF-Douglas GAM-87A Sky Bolt** two-stage solid propellant, air launched ballistic missile. Development phase is just beginning after prolonged delays in the study phase for Defense Department evaluation of the program.

• **Army-Western Electric Nike Zeus**, two-stage solid propellant, point defense antimissile missile. Three of the missiles have been fired with mixed success and the program is reported to be on schedule. Its future is uncertain as the Defense Department withholds funds for further evaluation.

• **Navy-Lockheed Polaris** two-stage solid propellant fleet ballistic missile. Polaris is schedule to join the fleet late this year. The past year has seen the program attain first fully successful flight of a full-scale missile, first in flight ignition of stage one after explosive launch from a simulated operational launcher, first full range, 900 mi. flight of an experimental series vehicle in September, first flight with partial use of guidance in December and launching of USS George Washington, first of the nuclear-powered Polaris submarines.

• **USAF-Martin SM-68 Titan ICBM**. Separation and second stage ignition were recently achieved after a nine month interlude in the program, which began auspiciously with four successive successful flights. At the end of the year, Air Force increased the cumulative value of the Martin contract to $510 million. Tests of the Titan hard base will begin late this year at Vandenberg AFB, Calif. Air Force has funded conversion to all-inertial guidance and is requesting money for development of in-silo launch to be used in all Titan bases after completion of the sixth operational one. Silo Launch Test Facility at Vandenberg AFB is nearly finished.

• **USAF-Convair SM-65A Atlas ICBM**. Air Force crews have fired two Atlases from Vandenberg AFB and the missile has been called operational. However, other elements of the total weapon system are reported not ready for operational status. Atlas is the planned booster for Projects Midas and Samos, missile early warning and reconnaissance satellites, and various space vehicles. The missile will soon be using Arma all-inertial guidance.

• **Douglas SM-75 Thor IRBM**. Only Western long range ballistic missile ready for combat. Thor has been deployed in Britain with the Royal Air Force and has a record of 87 firings, 12 by USAF and RAF crews. Thor has recently been improved by a 10% increase in thrust and the addition of a low-drag fairing over the nose cone.

• **USAF/Army Jupiter**. Scheduled for deployment in southern NATO countries. Reportedly Italy will have two Jupiter squadrons and Turkey one and there is a possibility each country may have one more squadron.

• **Army Martin Pershing**. Known as the Selective Combat Range Artillery Missile (SCRAM), this inertially guided, two-stage solid-propellant weapon is about to begin development firings at Cape Canaveral. Pershing launch complex was occupied in November, and missiles have arrived there.

• **New airborne and battlefield missiles** in development include Davy Crockett, man carried tactical nuclear weapon; Convair Red-Eye, bazooka-type infrared guided low altitude anti-aircraft rocket; Navy's Bendix-Grumman Eagle long range air-to-air missile; Air Force GAR-9 long rang air-to-air missile and GAR-11 nuclear armed air-to-air missile, both Hughes Aircraft projects; Aerojet-Stroma Shillelagh light weight surface-to-surface missile, and the North American GAM-77 Hound Dog and the Temco Corvus stand-off missiles.

Also in the works are such advanced missiles as Project Slam, nuclear powered ramjet and its chemical ramjet cousin Project Clam. If Project Slam is continued, it will be based on the progress of the nuclear ramjet Project Pluto, partially sponsored by the Atomic Energy Commission.

Of the $13.6 billion which the Defense establishment expects to spend upon procurement this year, almost $3.5 billion will be spent on missiles. Total annual missile expenditures are hard to derive because some of the figures are lumped with those for aircraft under other headings. For the three service departments, missile procurement expenditures planned are:

• Air Force—$2.67 billion.
• Army—$413 million.
• Navy—$397 million.

Most military missions for missiles

THOR WITH NEW NOSE

LOCKHEED POLARIS

MARTIN PERSHING TEST VEHICLE

can now be accomplished within the present boundaries of missile technology. Competent scientists and industry executives report that the process of designing a missile is approaching the endless round of refinement and improvement familiar to aircraft designers.

There are notable exceptions in the field of guidance and ground support. Guidance design may be protracted into a never-ending cycle by continuous development of electronic countermeasures.

The growing role of the missile in warfare is causing profound changes in the character of the industry and these can be expected to continue or even accelerate in the first few years of this decade. Characteristics of missiles which are bringing about these changes:

- **Simple airframes** which reduce the requirement for production man hours, detailed engineering and high bay factory area.
- **Heavy dependence** upon electronic guidance and flight control.
- **Difficulty of obtaining** any large amount of development test data and even greater difficulties in production testing because missile flights are one-way trips.
- **Extreme reliability** requirements generated by the impossibility of correcting or compensating for a malfunction after launch. It is this requirement more than any other which accounts for the fact that ground support for a ballistic missile costs more than the missile itself.

Shifting Skills

The effect has been to change most of the supply and demand patterns of defense industry. A notable one has been the rise in demand for engineers and scientists specializing in esoteric fields and the easing of demand for mechanical designers of general competence. Electronics engineers, physicists of all types, mathematicians and thermodynamicists with impressive academic accomplishments are much sought after. Large companies are now quite ready to spend considerable sums of money for the purpose of acquiring a single gifted employe.

This change in the type of know-how required, the lesser need for high bay factory area and the different tooling and techniques are forcing some companies to fight off a decline and have attracted newcomers to compete in what has become a technological free-for-all.

Rapid development of new weapons has caused the rise of the "proposal shop" with its large numbers of professional and skilled people specializing in making technical presentations and preparing bids on widely varying types of military contracts.

A detailed analysis of the impact of

the missile on the international situation was prepared for Senate Foreign Relations Committee by the Washington Center of Foreign Policy Research of Johns Hopkins University (AW Dec. 21, p. 68). The analysts preparing the report estimated that the U. S. will have slightly more than 100 operational ICBMs by the end of 1962. The degree to which this number could be expanded seems to be limited by the rate at which bases can be established rather than by production rate. "With even a crash program of base construction," the report said, "it is difficult to imagine how the U. S. force could be increased to more than 300 missiles by 1963." Soviet inventory could be 1,000 or more.

The Polaris Fleet Ballistic Missile was not considered at length because of the small number to be available at the anticipated height of the missile gap in 1962 and 1963.

Effect of Gap

The Johns Hopkins report looked at the effect of the missile gap upon tactical intelligence, noting:

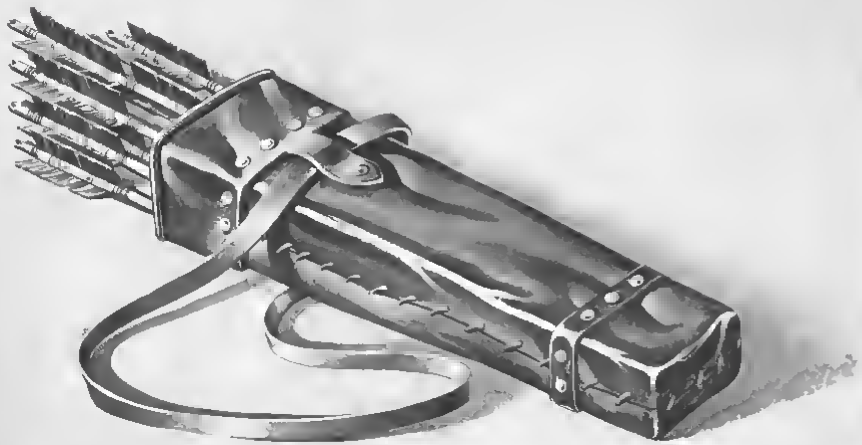
"Once missiles are introduced the importance of the Soviet intelligence advantage assumes almost staggering proportions at a time when U. S. strategic power remains centered in a manned bomber force. While the Strategic Air Command might now receive no warning whatsoever of a missile attack, and may never get more than the 15 to 20 min. warning that sophisticated radars may provide, there is even less chance that the majority of the Soviet missile bases can be located in advance of a war. It thus becomes exceedingly doubtful that the Soviet missile force could be effectively attacked by an American first strike."

The introduction by the U. S. of dispersed, hidden and mobile solid propellant ballistic missiles should bring another stalemate between the U. S. and the Soviet Union. The report implied that an incentive now exists for the Soviet union to strike first. It called for top priority efforts to cut the vulnerability of U. S. strategic forces during the existence of the missile gap by the traditional devices of mobility, concealment, hardening and dispersal.

Also called for was accelerated development of Minuteman, which the analysts apparently regard as the primary means of closing the Soviet missile lead. Short countdown and hardened or mobile bases are the chief military advantages of Minuteman, but cost factors are also important.

A larger number is needed to do the job than with liquid propellant first generation missiles, but unit cost of Minuteman is much lower. A Minuteman completely equipped and deployed costs $1–$2 million. One of the first

CONVAIR ATLAS ICBM



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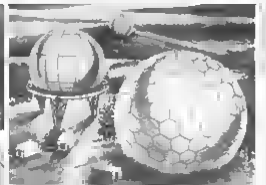
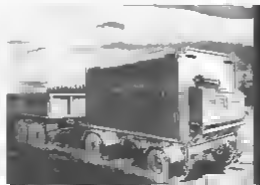


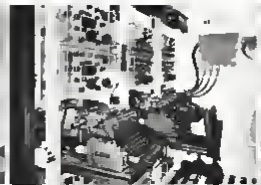
AIR TRANSPORTABLE SHELTERS

MOBILE GROUND SUPPORT



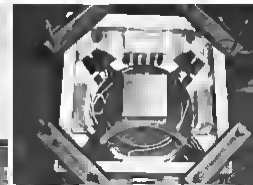
MISSILE SUPPORT

ELECTRONIC SYSTEM INSTALLATIONS



TELESCOPING MASTS AND CONTROL TOWERS

ENGINEERED TRANSIT CASE UNDER TEST



generation liquid propellant ICBMs costs about $10 million in the same circumstances. The best force level for Minuteman is estimated variously between 500 and 2,600 missiles.

At least five boilerplate versions of Minuteman have been fired in silo launcher proving tests at Edwards AFB. To date, problems encountered in the 83-ft. deep launching holes are primarily associated with feedback of acoustic energies into the missile structure.

Stage one propulsion development is reported slightly behind schedule. The next phase of in-silo firings at Edwards will test lightweight motor cases more like the ones to be used in the actual missile.

Test firing facilities are now being prepared at Cape Canaveral. Present series of firings at Edwards will continue until April or May.

Because of the great numbers of Minuteman bases contemplated, economical design of the silo is vital. Three types of design have been considered:

- U-tube design in which the rocket efflux rises out of one mouth of the tube and the missile from the other.
- Annular silo similar in principle to the U-tube but with the efflux allowed to escape from an annulus surrounding the launcher.
- Simple, closed bottom silo with a flame deflector to protect the missile. This is the launcher most likely to be selected. Tests at Edwards show no reason to doubt its feasibility. Cases used in Edwards tests are only partially loaded for short burning time. Other part of the propellant grain is simulated.

The question of the value of the Air Force-Douglas GAM-87A Sky Bolt air launched ballistic missile may still be debated in some quarters because it is no less vulnerable to attack on the ground than the bombers that must earn it. But Department of Defense has finally decided to support the new weapon (AW Feb. 28, p. 26).

Quantity Required

If the missile reaches operational status, the number ordered will have to be high because of the number of aircraft on which it would be mounted, spares requirements, development needs and air crew training.

When Polaris becomes operational late this year it will be earlier than anticipated at beginning of the program, partly because of speed in the development of the launching submarines. Follow-on to the 598-class nuclear-powered, Polaris launching submarines will be four larger vessels of the 608-class with improved hull design.

Navy is projecting Polaris armament for cruisers and cargo vessels. The latter would carry no other armament and would be converted as cheaply and secretly as possible to make every cargo ship look like a potential threat to an enemy.

A critical problem faced in the Polaris program has been the shipboard navigation system. Unlike other current long range missile systems, the precise launch point cannot be known in advance. Position and guidance data for Polaris will be continuously calculated by a Navigation Data Assimulation Center (NAVDAC) which draws navigational data from over a dozen position fixing instruments including an inertial navigation system, an optical periscopic sextant, and a radio sextant which can draw celestial lines of position from the sun, moon and radio stars. NAVDAC computer weighs each input against the others and calculates which source is providing the most probable accurate position data.

Range Compromise

A compromise made necessary by the Polaris program speed-up was a reduction in the planned range of the first missiles to join the fleet. When the target operational date was 1962, range of the first operational missiles was to have been 1,500 mi. Advancement of the date to late 1960 obliged the Navy to settle for a 1,200 mi. range goal. Present indications are that this objective will be met this fall. The original 1,500 mi. range may be attained before the 1962 date first set for it.

Radical modifications are being studied in the hope of extending the range even farther or increasing the payload weight. One such proposal would use hybrid solid fuel-liquid oxidizer propellants. Inert Polaris shapes simulating the static and dynamic characteristics of the missile will be launched submerged from USS George Washington, first of the Polaris submarines, before live missiles are launched.

In the propellant field the most significant development, perhaps, is the conversion now officially approved, of the Titan ICBM from cryogenic to storable propellants. The substitution of storable propellants could cut the required countdown time by 25%, according to some missile men.

Another significant development during the past year is the decision to go to liquid hydrogen in the upper stages of the Saturn space booster. At the moment, this is not considered of much import for military missiles for which the more conventional liquid chemical propellants appear adequate. Hydrogen's high energy teammate, liquid fluorine, is still being tested on a development scale. Many propulsion people feel that the extra impulse fluorine offers over liquid oxygen isn't worth the handling and pumping problems involved in turning fluorine into a practical high energy rocket oxidizer. Some others such as Bell Aircraft engineers feel that these problems have now been solved.

GE MK 3 NOSE CONE ON ATLAS

Liquid ozone continues to be a subject of interest to a small group of chemical researchers, few of whom hold any hope for it as a future oxidizer. Ion and plasma propulsion, once considered much more exotic than even such things as liquid ozone, is being pushed into the realm of practicality by a large number of companies and government groups. Here again, however, the interest is angled almost wholly toward space vehicles, except for military satellites.

In the military missile area, two major research efforts besides the work on high energy storables are aimed at the development of high energy liquid monopropellants and high energy solids. High energy means roughly a specific impulse of 300 sec.

The greater effort currently is the one on solids. Two of the more promising approaches to high energy solid propellants at present appear to be through the use of boron derivatives and solid fluorine compounds. High energy solid propellants based on nitric esters also hold promise, chemists say, provided the problem of instability can be overcome.

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

ADVANCED PROJECTS AT LOCKHEED

POLARIS FBM – Now in its advanced development status, the Navy-Lockheed Polaris Fleet Ballistic Missile is scheduled to be fully operational and aboard its specially designed submarines late this year. Full-scale test vehicles have been successfully flown on a regular schedule of firings for months with only two failures, a remarkable achievement in view of the totally different environmental problems involved in its underwater launch requirement. With three-quarters of the earth's surface being water, practically no target in the world is outside the Polaris range of over 1200 nautical miles. The Division is systems manager for the Polaris under the direction of the Special Projects Office of the Navy.

SPACE STATION – An orbiting research facility, to serve as an advanced base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by ballistic missiles and assembled in space by means of the specially-designed Lockheed Astrolug.

X-17 KINGFISHER – The Air Force-Lockheed X-17 solid-propellant ballistic missile has pioneered many new techniques and the valuable experience gained from this program facilitated development of other, inter-service projects including the Navy Polaris FBM. The Navy's Project Argus radiation explosion featured the X-17 as the vehicle. Developed for the Air Force, the Lockheed Kingfisher is designed to simulate enemy attacks to test our nation's anti-bomber and anti-guided-missile defenses. The Air Force X-7 is a unique, recoverable ramjet-engine test vehicle designed to test new developments in advanced components for other missiles.

SATELLITE PROGRAMS – The Air Force Lockheed Agena satellite is a versatile space vehicle capable of numerous assignments. In its present configuration, it is 19 feet long, 5 feet in diameter with an orbital weight of approximately 1700 pounds. Payload of several hundred pounds includes telemetry, instrumentation, guidance and attitude control systems, re-entry vehicle and recovery capsule. The Agena has accomplished several significant space firsts. It was first to be placed on the difficult polar orbit, first to be placed on a precise, predicted, and nearly circular orbit, first to change its attitude on orbit with a turn of 180 degrees and a downward tilt of 60 degrees, first to eject a capsule, and first to prove advanced space systems such as ground-space communications, instrumentation, attitude and guidance and life-sustaining devices. The Agena can be modified for a variety of space missions such as navigation, geophysical investigations, lunar probes, long-range communications, and space probes.

In addition to the Agena program, the Division is developing satellites for the Midas program (Missile Defense Alarm System) and the Samos strategic warning system. Lockheed is systems manager for these projects under the direction of the Air Force Ballistic Missile Division (ARDC).

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. C-17A, 962 W. El Camino Real, Sunnyvale, California. U. S. citizenship or existing Department of Defense clearance required.

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Circle Number 133 on Reader Service Card

Ground Support Stresses Silos, Hard Site

By Richard Sweeney

Ground support equipment research and development effort is advancing on two fronts—for the new generation solid propellant Minuteman intercontinental ballistic missile and Polaris fleet ballistic missile and on improved sites for liquid-propellant Atlas and Titan ICBMs.

Work on solid fuel missile systems was emphasized in these areas:

● Minuteman silo. Dimensions were firmed earlier than had been anticipated as tests at Edwards AFB proved the three-stage missile could be fired efficiently from a silo with walls only 3.5 ft from the missile. Another fairly firm part of silo design was the exhaust deflector at the bottom. Still remaining was determination of the system for protecting the missile against earth shock which would result from nearby detonation of a high yield warhead; design of the silo cover actuation system and provisions for work platforms and other maintenance features inside silo.

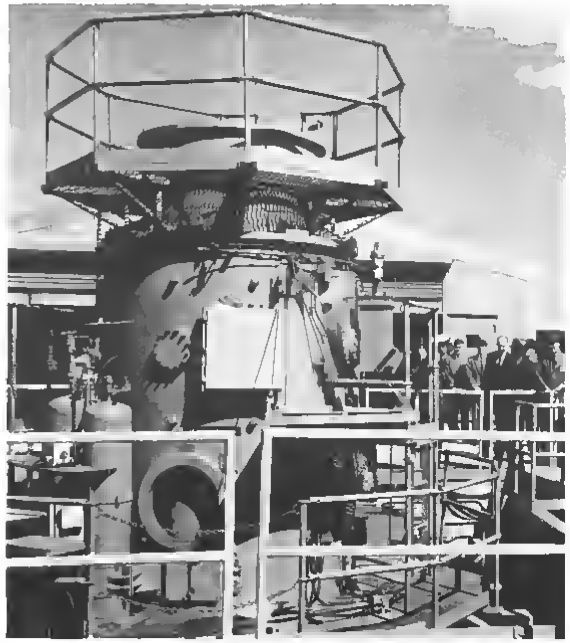
● Polaris. Regular and frequent flights were being made down the Atlantic Missile Range for 900 mi. after the two-stage, submarine-carried missile was launched from the ship-motion simulator tube at Cape Canaveral. Work progressed on navigation systems for the submarines, as well as on the automatic control system and stabilization equipment. The round-hulled submarines are highly unstable surfaced particularly when stopped or at low speed. Polaris submarines also will use manual control systems, pilot displays and "flight path" techniques highly similar to airplanes—turns are banked like a plane due to high vessel speed.

On the liquid-propellant ICBM systems, development involved:

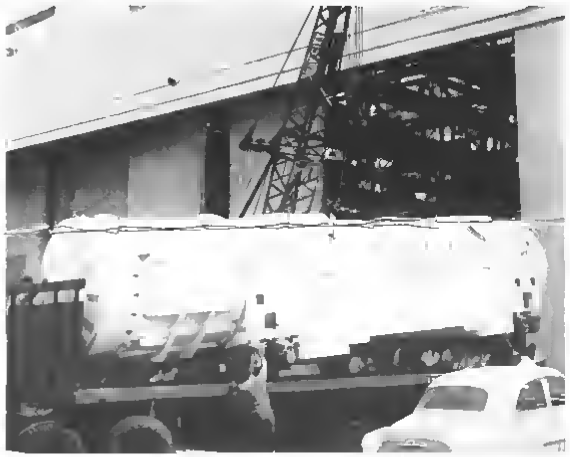
● Atlas. Development was under way on a hardened silo site, with the missile to be lifted to the surface on an elevator for launch. The new hard Atlas site was to have one launch control center per silo, with the nine silos per squadron located about two miles apart. A silo test facility is under construction at Vandenberg AFB for Atlas.

● Titan. A silo launch test facility (SLTF) is under construction at Vandenberg AFB for Titan with the difference that it is to test the missile for launch from the silo bottom like Minuteman. Flight test of Titan is continuing at Cape Canaveral and an operational suitability test facility (OSTF) and Training Facility One (TF 1) also are being built at Vandenberg and expected to be ready by the end of 1960.

What may well be the most intensive



POLARIS SHIP MOTION SIMULATOR



POLARIS SHIPPING/LOADING CONTAINER

and complex research and development program in USAF history is being conducted for Minuteman, targeted to be the simplest, most reliable and economical system now feasible.

Ground support equipment keystone of Minuteman weapon system is by far the most costly portion.

Minuteman concept now calls for various parts of the missile to be shipped to an assembly center where the entire missile will be put together, then taken to the silo after checkout.

The transporter-erector projected to take Minuteman from assembly center to silo and to lower it into the silo will consist of a tractor prime mover and a container in the form of a semi-trailer. This will carry the complete missile weighing 70,000 lb. to 80,000 lb. In addition, the container itself will have to be carried on a standard railroad flatcar.

General Motors Corp., Cessna Aircraft Co. and Bendix Pacific Div. were subcontractors on the transporter erector to Boeing, which was responsible for integration under the assembly and test contract. GM designed and built a prototype prime mover and rear bogie for the container, Cessna the container and its equipment. Bendix Pacific designed and built the hydraulic system which erects the container over the silo so that the missile can be lowered into position.

Poloris Equipment

Although it is floating rather than ground support equipment probably the most expensive component in the Polaris weapon system is the submarine which carries and launches the weapon. First of the nuclear-powered Polaris submarines, the 598 class George Washington is scheduled to be on station by December carrying its complement of 16 two-stage, solid propellant missiles.

Later, larger submarines, designated 608-class, will carry the missile.

Missile support equipment aboard the submarine includes:

• **Launch system,** including the tubes, hatches, reservoirs of gas which propel the missile from the tube to above the ocean surface plus the control valves for the hatches and reservoirs, much of which was designed and built by Westinghouse. Umbilical cords for the missile are provided by Lockheed.

• **Launch control** and checkout equipment. Nortronics Div. of Northrop Corp. is designing and building checkout equipment for the first five Polaris submarines under Lockheed's technical direction. However, a more sophisticated system called Automatic Checkout Readiness Equipment (ACRE), designed by Lockheed, will be used on subsequent vessels and may be retrofitted to the first five.

• **Fire control system,** incorporating a computer which gets data from several sources, processes it and sends along the proper information for the General Electric guidance system to use in directing the missile to the target. These data include submarine position, submarine attitude, missile trajectories and target position.

• **Submarine attitude stabilization** equipment, also special for the vessel, includes a Sperry gyro weighing about 62 tons. Primarily this is to provide stabilization in roll when subs are surfaced and cruising very slowly or stopped. Gyro's stabilizing capability reportedly approximates a factor of 10—a 40 deg. roll would be damped to 4 deg. The submarines also have inclinometers in roll and pitch axes which send data to the fire control system and prevent missile launching if attitude exceeds preset limits in either axis. Polaris subs also have automatic course and depth holding controls similar to an aircraft autopilot.

Launch tube covers on Polaris submarines are made of soft iron and are designed to blow out at 25 lb. internal pressure. This enables Polaris to be launched through the hatch should it malfunction and refuse to open at proper time.

Tube Access

Launch tubes have doors at several levels to provide access to missiles for plug-in module changes and such maintenance as can be done while Polaris is in the tube.

Inner surface of the launch tubes has a milled finish after which surface plating is applied to a controlled depth. This leaves a gap between launch tube walls and current Polaris missiles providing for diameter increase in later models if desired. Wadding rings now are wrapped around the missile as spacers to ensure proper centering and provide a piston ring effect when the launching gas charge is released at the base of the tube.

Operational Polaris missiles are loaded aboard the submarine using part of the Lockheed-designed shipping container. This container is composed of the external shell, environmental and protective equipment, and a glass fiber inner liner which fits the missile like a glove.

Inner liner and missile are pulled from the 16,500-lb. main container as a unit at dockside or aboard a tender at sea. A crane lifts liner and missile onto the sub deck. The bottom of the inner liner is positioned at the top of the launch tube and fastened securely. The liner has the same inside diameter as the launch tube serves as an aligning tool to guide precisely the missile into the tube. Top of the inner liner incorporates an integral hoist which then

TITAN SILOS UNDER CONSTRUCTION AT DENVER

lowers the missile, with its wadding rings, into the launch tube. Liner-hoist then is unfastened and returned to the shipping container.

Lockheed also is developing smaller containers to ship the missile in parts first stage, second stage, re-entry vehicle guidance package. Up to now, the solid propellant rocket engine contractor has delivered first and second stage engines of the test vehicle, to the launch site as individual parts, minus only their final coat of paint, and Lockheed performed final assembly and checkout prior to launch.

Ground support equipment for Martin's two-stage Titan ICBM under went additional research and development last year aimed at giving launch capability from the bottom of a silo similar to Minuteman, achieving a large reduction in the time the silo would have to be open for a launching.

Planning was that research and development would be far enough along to incorporate silo bottom launch at Titan bases T-7 through T-13. Total of 14 Titan squadrons have been authorized, but two will be sited at Lowry AFB, Denver reducing number of sites to 13. Each squadron will have nine missiles in silos, plus a spare.

Construction of operational facilities for the silo bottom launch is expected to reduce over-all weapon system cost, in that the elevator which lifts Titan to the surface for launching in sites now being built is eliminated. Also, radio command missile guidance system antennas and associated electronics would be eliminated in later versions.

Ground support equipment currently being designed and fabricated for installation in the Titan operational suitability test facility (OSTF) and Training Facility One (TF-1) at Vandenberg provides for:

- Storing and checking the missile in the hardened (cover in place) silo propellant supplies from underground tanks, work platforms at various levels for missile maintenance and checkout.
- Elevator for the missile and the antenna protective and elevating system (APES) for the radio-command guidance.
- Test equipment to check GSE operation without having to perform actual movements. Missile elevators are capable of and will lift the ICBM to the surface for launch after fueling at missile gross weight approximating 220,000 lb., plus umbilicals control lines, lox topping line and other equipment.

Another item of Titan GSE which may undergo change for later base configurations are the transtainers, one for each stage, which transport and serve as containers for the missile between factory and site. These vehicles may incorporate integral hoists to lower stages into the bottom-launch type silos where elevators are not used.

Launch control equipment (LCE), Martin-developed, is highly simplified for operators. If there are no holds or other problems, Martin says three men at three consoles can handle the launch control equipment.

LCE constantly monitors certain key systems and subsystems with capability for tracing the trouble to the replaceable module level.

Atlas at Vandenberg

Construction started in mid-1959 on a silo test facility for the Atlas ICBM at Vandenberg AFB. The missile will be elevated to the surface for engine ignition and launch—the entire operation projected to take less than a minute. Six of 13 programed Atlas squadrons will use this hardened silo concept.

Combination of short exposure time for Atlas in launching from a silo type site, plus use of inertial guidance (which operates constantly), have speeded the missile's reaction time significantly, and additional time will be gained by keeping the missile loaded with JP-4 fuel as well. Liquid oxygen oxidizer will be stored in a thermos flask type container in the bottom 65 ft. of the 145-ft.-deep silo, sharing the space with machinery for the elevator which lifts Atlas to surface and the pumps which transfer the oxidizer from storage to missile.

To protect the missile, machinery, and oxidizer tank from blast shock wave which would travel through earth from a near-miss by megaton warheads a steel girder crib will surround these parts of the system. Crib is isolated from the silo's concrete and steel wall by springs. Everything within the crib will live through any shock which does not collapse the entire silo.

Each silo will have its own launch control center underground, linked to it by a tunnel.

First three Atlas squadrons will use soft bases, with missiles stored horizontally but raised to the vertical for propellant loading, final checkout and launch. Soft sites are Warren AFB, Wyo., Forbes AFB, Kan., and Fairchild AFB, Wash.

Between the first three soft sites and hardened silo squadrons four additional Atlas squadrons will store Atlas in a horizontal position, but inside a concrete coffin which gives the missile some degree of protection in case of attack. These semi-hard sites also will have the launch service building which houses propellant either partially buried or at least surrounded with earth mounds to afford more protection.

Atlas squadrons will have 10 missiles each, nine emplaced for launch, and one spare.

Costs for the various site configurations vary widely. Soft sites run about $22 million per squadron, semi-hard sites about $29 million. Silo sites will cost about $44 million per squadron.

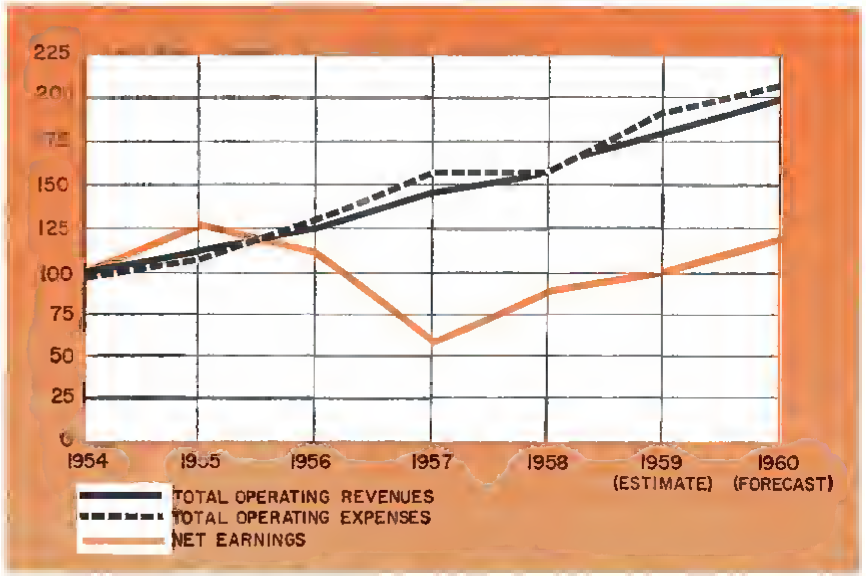
Both U.S. intermediate range ballistic missiles were operational last year; Thor deployed with the RAF in Britain, and Jupiter with U.S. troops in Italy. Ground support equipment for both remained relatively unchanged. Biggest modification was addition of a tillerman steering position on Thor transporter-erector and communications with the front driver. Addition was necessitated by narrower and more twisty roads in Britain than had been encountered in U.S. during GSE development.

Delta Airlines Douglas DC-8 jet transport.

Air Transport

Domestic Trunkline Revenue-Cost Trends

(Chart is based on an index with 1954 as base year equaling 100. Figures do not represent dollars.)



Jet Acceptance Spurs Trunkline Gains

By L. L. Doty

Washington—Domestic trunkline business, sparked by a rapidly growing public acceptance of turbojet and turboprop aircraft, appears headed for another record year.

Despite a rash of highly publicized accidents during the opening weeks of the year (AW Jan. 18, p. 37), the trunkline industry got off to a fast start toward producing a projected 33 billion revenue passenger miles in 1960—an increase of 14% over last year's estimated 28 billion. Gross revenues are expected to climb 16% to top the $2 billion mark for the first time. Revenues last year reached an estimated $1.7 billion.

Net profits for the trunkline industry may climb as high as $61 million for the year, a substantial increase over the estimated $52 million earned last year but still slightly short of the all-time high of $63.1 million realized in 1955. As in the past, however, total industry profit probably will not accurately reflect the true health of the industry as a whole since the bulk of that profit will be made up largely of earnings of four or five at the most, of the 12 trunk carriers.

Nevertheless, the outlook is good and optimism over the prospects of a continuing traffic expansion throughout 1960 is shared by a majority of top industry leaders. Admittedly, a number of factors threaten this rosy outlook but, generally, most observers feel that last year's recovery from 1958's traffic depression will be accelerated this year at an even more rapid pace.

Airline Problems

If any doubts do exist, they lie in these principal areas:

• **Rising expense level.** Depreciation expense and interest costs on long-term loans covering the purchase of new equipment will appear this year on balance sheets as major cost items. Coupled with a continuing climb in the general expense level, such costs put new pressure on the three-year old profit squeeze which has held profit margin on sales to a low 2.9% since 1958. A wave of inflation on a national scale this year—which economists are not ruling out as a strong possibility—could erase the full profit potential of a number of small carriers.

• **Capacity.** Trunklines will receive most of their turbine equipment on order by the end of the year, adding materially to the number of available seat miles the industry will produce. It is estimated by AVIATION WEEK that turbojet equipment alone—exclusive of turboprop and piston engine equipment—will generate an annual rate of some 21 billion available seat miles by the beginning of 1961. This compares with the total 45 billion available seat miles produced last year by all types of equipment operated by the trunk carriers. Accelerated retirement rate of piston engine equipment could relieve this problem substantially. However most observers feel that the used plane market will not bear any excessive dumping of second-hand airplanes at this time and they are watching for load factors to dip from the spectacularly high level reached last year as more turbine equipment is placed into schedule.

As of the end of 1959, a total of 68

Comparative Direct Operating Costs

(Cents per plane-mile, 12 months ended June 30, 1959)

	Flying Operations	Direct Maintenance	Applied Maintenance Burden	Depreciation	Interchange Expense	Total Direct Operating Expense
Domestic Trunk Lines						
DC-3	40 38	13 38	8 83	0 73		63 32
CV-240	46 51	21 03	19 18	(1 41)		85 23
CV-340	45 54	17 48	12 51	18 90	0 73	95 16
CV-440	43 73	19 09	9 78	22 45		95 05
M-202	118 75	15 62	28 12	3 12		165 61
M-404	49 64	21 04	12 57	7 76		91 01
DC-4	57 01	28 86	14 87	(0 29)		100 45
DC-6	58 60	20 91	18 68	0 36	6 32	104 87
DC-6A	63 47	21 01	19 66	22 28		126 42
DC-6B	65 38	18 63	13 76	15 50	3 55	116 82
DC-7	63 37	31 45	20 90	32 14	5 88	153 74
DC 7B	69 10	26 48	11 47	32 65		139 70
DC-7C	70 73	30 21	16 21	29 04		146 19
L-049	69 67	27 14	18 54	15 01		130 36
L-749	67 34	25 53	15 96	6 01		114 84
L-1049	71 99	38 80	19 71	15 77		146 27
L-1049C	73 89	30 95	12 91	1 00		118 75
L-1049G	71 90	32 19	17 64	34 62		156 35
L-1849H	70 48	25 14	15 99	37 37		148 98
L-1649A	66 80	30 69	19 30	35 70		152 49
C-46	42 96	20 72	11 88	15 58		91 14
Ladestar	43 24	7 20	21 02	(10 81)		60 65
B-377	84 54	41 49	19 80	4 73		150 56
Viscount	51 23	23 53	11 12	23 24		109 12
Electra	61 89	28 55	12 38	39 73		142 55
B-707	109 50	31 08	12 10	31 08		184 36

Boeing 707 turbojet transports, including 18 intercontinental versions of the model, had been delivered to U S carriers. Both Delta Air Lines and United Air Lines began scheduled service with Douglas DC-8 transports powered with Pratt & Whitney JT3 engines in September and, at the end of the year, United had taken delivery on eight of this model and Delta Air Lines had received all six of the fleet it had on order.

Both Eastern Air Lines and National Airlines took delivery on the first of their orders for Douglas DC-8s powered with the JT4 turbojet engine. Two carriers operated turbojet scheduled service through lease arrangements with other carriers. Northeast Airlines through a lease contract for Boeing 707-320 turbojets with Trans World Airlines and National Airlines through the lease of Boeing 707-120s from Pan American World Airways.

Jet Orders

Continental Air Lines began Boeing 707 service in June and by the end of the year had received its total order of four of the turbojets. Northwest Airlines is scheduled to receive the five Douglas DC-8s it has on order this year. Braniff began Boeing 707 service late in 1959.

At the beginning of 1960 Delta took delivery on the first of its fleet of 10 Convair 880 turbojet transports. Capital Airlines and TWA also have this model on order for delivery this year. The Convair 600 will make its initial appearance in 1961 when the first of

UNITED AIRLINES BOEING 720.

DOUGLAS DC-8s ON LINE FOR DELIVERY

Domestic Trunklines——Traffic and Revenues

TRAFFIC	1955	1956	1957	1958	1959 (estimated)
	(000 omitted)				
Number of Passengers	41,600	45,900	49,300	49 100	55 600
Revenue Passenger Miles	24,340,400	27,612,000	31,243,100	31,481,900	36,215,300
U S. Mail Ton Miles	142,500	152 500	160,700	187,500	197,500
Express Ton Miles	51,000	52,700	46,100	48,800	59,400
Freight Ton Miles	382,900	451,300	507,700	501,500	595,400
Total Revenue Ton Miles	3,022 200	3,527,400	4,004,400	4,074,700	4,676,100
REVENUES	(000 omitted)				
Passenger	$1,021,900	$1,142,200	$1,287,200	$1,363,000	$1,620,700
U S Mail	26,900	31,600	33,800	36,100	40,300
Express	19,400	18,100	14 700	16,100	19,800
Freight	39,600	42,200	49 900	57,400	67,800
Other	25 500	28,700	34 000	40 600	40,400
Total Revenues	1,133,300	1,262,800	1,419,600	1,513,200	1,789,000
Operating Expenses	1,010,100	1,262,800	1,377,600	1,418,100	1,684,000
Net Operating Income	123,300	100,600	42,000	95,100	105,000
Net Profit (after taxes and interest)	63,100	57,700	27,000	44,400	52,000
Profit Margin on Sales	5 6%	4 6%	1 9%	2 9%	2 9%

Domestic Trunk Airline Load Factors

	1959	1958
American	70 2%	66.1%
Braniff	58 17	59 1
Capitol	58 4	57 9
Continental	54 8	51 2
Delta	57 1	58 5
Eastern	50 77	52 79
National	55 04	56 1
Northeast	50 3	47 4
Northwest	55 6	55 4
Trans World	70 5	64 5
United	66 8	64 6
Western	60 5	54 5

25 on order by American are slated for delivery.

By the end of the year, 103 Lockheed Electra turboprops had been delivered to U S trunklines with a balance of 32 remaining for delivery. In operation were 68 Viscount 745 turboprops and 15 Viscount 812s. Yet to come this year are a total of 154 turbojets including the Boeing 720 medium-range transport.

Turbojet equipment operated by TWA and American produced high load factors that ran as high as 90% during a substantial portion of the year. Effect of the turbojets on traffic growth was demonstrated last year by the hike in system load factors experienced by the jet operators.

Load Factor

American's system-wide load factor for the year climbed to 70.2% from 66.1% last year and TWA moved to 70.5% from last year's 64.5%. Continental boosted its load factor from 51% in 1958 to 54.8% in 1959.

By the end of the year, all but two carriers had completed financing of their new equipment and had successfully introduced the aircraft into scheduled operation with a minimum of maintenance and operating difficulty.

Northeast now is working out its financial program for new aircraft, probably the Convair 880, and Capital last month had undertaken a new refinancing program that will enable it to follow through with its plans to buy five Lockheed Electras and four Convair 880s.

New orders can be expected to supplement present fleets. United Air Lines is giving serious thought to the purchase of a fleet of Caravelle twin-engine turbojet aircraft manufactured in France by Sud Aviation. Northwest's President Donald W. Nyrop recently said he sees a "definite need for development of a small jet transport for use in intermediate station service."

The year 1960 saw the first full year of operation of the newly organized Federal Aviation Agency headed by E. R. Quesada. Highlight of the year was the implementation of Quesada's rigid enforcement program which was brought into public focus by 1959's high accident record of 270 passenger fatalities.

The enforcement program bred a bitter wrangle with the Air Line Pilots Assn. which charged the agency with "dictatorship." Chief bone of contention in the battle was ALPA's strong opposition to a rule calling for retirement of pilots at the age of 60 and an age limitation of 55 for jet pilots.

Here are some of the other new regulations introduced by the FAA.

- **Requirement** that at least one pilot will wear an oxygen mask at all times when flying at altitudes above 35,000 ft.
- **Ruling prohibiting** airmen from operating if their medical background showed such illnesses as diabetes mellitus requiring insulin, coronary artery disease, history of psychosis and other mental diseases.
- **Enforcement of requirement** that crew members on commercial transports remain at their duty stations at all times. ALPA is vehemently protesting this ruling.
- **Requirement** that all airline aircraft

Total Traffic on U. S. Common Carriers

	1958 (ACTUAL)		1959 (EST.)	
	Passenger-Miles (millions)	Percent of total	Passenger-Miles (millions)	Percent of total
Air	25 3	43 0	29 0	47 1
Rail	18 5	31 4	17 7	28 7
Bus	15 1	25 6	14 9	24 2
Total	58 9	100 0	61 6	100 0

Consumer price index for 1/9/59 (on basis of 100 month) 256.3
Public Transportation " " 238.8
Regular route intercity passenger miles of Class I motor carriers engaged in intercity service

Domestic Trunkline Orders for Turbine Aircraft

Airline	Aircraft	Number Delivered	On Order For Delivery In 1960	1961	1962	Total
American Airlines	Boeing 707	23	2			25
	Boeing 720		11	14		25
	Convair 600			10	15	25
	Lockheed Electra	25	10			35
Braniff Airways	Boeing 707	1	3			4
	Lockheed Electra	8	1			9
Capital Airlines	Convair 880 M		4	3		7
	Vickers Viscount 745	61				61
	Lockheed Electra		5			5
Continental Air Lines	Boeing 707	4				7
	Vickers Viscount 812	15				15
Delta Air Lines	Douglas DC-8	6				6
	Convair 880		10			10
Eastern Air Lines	Douglas DC-8		12	4		16
	Lockheed Electra	40				40
National Airlines	Douglas DC-8		3			3
	Lockheed Electra	12	11			23
Northeast Airlines	Vickers Viscount 745	10				10
Northwest Airlines	Douglas DC-8		5			5
	Lockheed Electra	10				10
Trans World Airlines	Boeing 707	15				15
	Boeing 707-331	4	8			12
	Convair 880		30			30
United Air Lines	Boeing 720		13	5		18
	Douglas DC-8	10	22	8		40
Western Air Lines	Lockheed Electra	5	4			9
	Boeing 720				3	3
Total		332	154	44	18	464

be equipped with airborne weather radar

During the year, FAA control towers handled a total of 26.8 million landings and takeoffs—a 1% increase over last year—and air route traffic control centers handled 36.6 million fix postings, up 6% over the previous year

Maintenance Inspection

Federal Aviation Agency also tightened airline maintenance inspection practices during the year, resulting in the filing of a number of violations against several carriers. In most instances, however, violations did not pertain to operation and performance of turbojet equipment with respect to maintenance.

In fact turbojet performance in scheduled service was found by the FAA to be superior to that of the majority of the four-engine piston powered aircraft serving the airlines. For example, during its first eight months of jet operations, Pan American maintained an 8.88 hr. utilization while accumulating 64,000 engine hours of flight time and experienced only five in-flight engine shut downs to give the carrier a record of 13,000 engine hours per engine shut-down.

American reported a reliability factor with its Boeing 707s which was four times greater than that recorded for the Douglas DC-6. In five months of jet operations, TWA's Boeing 707s completed 99.8% of scheduled miles and cancelled only two flights out of 886 scheduled. TWA experienced two in-flight engine shut downs in that period neither of which required an engine removal.

CAB Activities

Civil Aeronautics Board final decision in the Great Lakes-Southeast Service Case and the St. Louis-Southeast Service Case late in 1958 resulted in the addition of three new carriers into the Florida market: Northwest, Capital and TWA. In the Chicago-Milwaukee-Twin Cities Case, Capital was given a route between Chicago and Minneapolis/St. Paul and Northwest was granted nonstop authority from the Twin Cities to Atlanta and Florida. Eastern's routes were extended to the Twin Cities as a second carrier for services to the southeast.

In other cases acted upon by the Board, improved services by local service carriers were authorized in the Texas-Mexico area and American airlines was authorized to fly nonstop on its New York-San Francisco route. Hearings on applications in the Southern Transcontinental Service Case were completed.

Extensive hearings in the Pan American-National Case have been completed and briefs have been submitted to the

DELTA AIRLINES CONVAIR 880

Board examiner. In this case, the Board is investigating an agreement involving a short term lease of jet equipment by Pan American to National, a long-term lease providing for the mutual seasonal leasing of jets, the acquisition of stock by each carrier in the other, and an option to Pan American to acquire additional National stock.

A Board examiner held that Atlas Corp., which controls Northeast Airlines, had acquired control of Transocean Airlines pursuant to a reorganization of Transocean Corp. of California, of which the airline is a subsidiary. The examiner, however, approved the reorganization as the only means of saving the airline from the bankruptcy.

ATA Inspection

On Mar. 10, the Board instituted an inspection of the activities of the Air Transport Assn. to secure information on the procedures and functions of the ATA. The Board investigation is still underway.

In January, 1959, the Board issued certificates of public convenience and necessity to 23 supplemental carriers to operate domestic services limited to 10 round trips per month between any pair of U.S. cities in individually ticketed passenger and individually waybilled cargo service. The supplementals may operate charter service domestically without any restrictions as to service frequency.

A main issue awaiting a final Board decision is the general passenger fare investigation which enters its fourth year in May. Most observers feel that a final decision was delayed because of disruptions in the make-up of the Board. In September, Louis Hector abruptly resigned from his position because of dissatisfaction with organizational structure and procedural functions of independent federal agencies.

In a detailed statement to the President, Hector outlined his views on the Board with suggestions for correcting the processes which he said bogged down Board decisions. Member Harmar Denny retired in November and Chairman James Durfee was nominated by the President for a judgeship in the Federal Court of Claims.

Whitney Gillilland of Iowa and Alan Boyd of Florida were named by the White House to fill two of the vacancies. AVIATION WEEK has learned that both members are studying the fare case with the purpose of participating in the final decision.

Tariff increases of 4% plus $1 per ticket were granted in February, 1958, and in October of that year certain discounts were eliminated resulting in an additional fare boost of about 3½%. Surcharge on jet fares was authorized.

Most carriers are looking to further rate increase authorizations in the final decision of the general passenger fare investigation as a major step toward relieving the current profit squeeze. Despite the drive for higher fares, however, one airline—National—has not

AREA RULE bulges take shape on wings of Convair's 600 jet transport mockup

Domestic Trunkline Traffic Activity During 1959 Compared With 1958

Month	Passenger Revenue Miles (in Billions)		Available Seat Miles (in Billions)		Load Factors (Per Cent)	
	1959	1958	1959	1958	1959	1958
January	2 05	2 07	3 40	3 51	60 36	58 95
February	1 81	1 72	3 31	3 08	57 72	55 76
March	2 30	2 00	3 80	3 42	60 44	58 55
April	2 25	2 03	3 71	3 38	60 63	58 80
May	2 28	1 86	3 80	3 50	60 09	56 13
June	2 61	2 28	3 84	3 63	68 13	62 81
July	2 58	2 24	4 00	3 75	64 38	59 70
August	2 71	2 38	4 08	3 77	66 47	63 16
September	2 50	2 10	3 84	3 60	63 56	58 24
October	2 38	2 10	4 01	3 48	59 35	60 22
November	2 16	1 78	3 84	2 90	57 08	61 36
December	2 37	1 78	4 06	2 66	58 41	66 83

been active in the case and several airlines have been experimenting with low, promotional type fares in an effort to attract new traffic away from competitive surface transportation.

In general, the dilemma within the industry as to whether fares should go higher or lower was succinctly summarized by Charles Beard, president of Braniff Airways. In announcing plans to stimulate day coach travel, he said: "we hear a lot about bringing fares down for the common man. But our experience has been that the common man prefers first class meals and service. By the middle of 1961, we will know whether the common man can be persuaded to fly coach on our routes, through lower fares."

Other steps to generate traffic through expansion of credit facilities by accepting Hilton and Diners' Club credit cards were introduced last year by several carriers. Automation of reservations systems, improved ticketing techniques and more modern ground handling facilities were introduced throughout the year as a further means of encouraging air travel.

In this connection, Robert Johnson, senior vice president of United Air Lines, said that airlines must realize that "new ideas along with more effective use of proven techniques, must be adopted to meet the great sales challenge which confronts the airline industry."

Johnson echoed the opinion of many industry leaders when he said that speed of the jets will draw additional passengers from both the railroads and highways.

In summarizing the economic outlook of the industry, C. R. Smith, president of American Airlines, had this to say:

"The type and price of airline service during the next 10 years in large part will depend upon the wisdom of the government. . . a great deal of federal regulation today appears to be unrealistic . . . and two areas are of timely concern . . . the amount of duplicating competition and the level of earnings allowed." He added:

"It would be well to give better attention to the basic tests of public convenience and necessity in the authorization of additional routes and services. . . ." He predicted that domestic trunkline traffic will reach 44 billion passenger miles by 1964 but urged that the CAB endorse the conclusion of its examiner that the trunklines require a rate of return on capital approximating 10-12%."

TWA CONVAIR 880

U.S. Flag Lines Face Jet Competition

By Glenn Garrison

Traffic growth of most U.S. flag carriers picked up again in 1959 after a slowdown the previous year but they entered 1960 facing perhaps the greatest competitive challenge ever offered on the international air routes.

This is the year in which major airlines throughout the world will begin moving their high capacity jet transports into the battle for traffic. Competition for routes and rights bitterly fought in 1959, will certainly not abate as the time-shrinking jets shrink national boundaries even further.

Pan American World Airways, only U.S. international operator of jets during most of 1959, carried about 250,000 passengers for the year in its Boeing 707-120s and 707-320s. The airline's jet network began across the North Atlantic was extended during the year through Europe, around the world, to the Caribbean, Bermuda, South America and Hawaii.

By the end of 1960, Pan American's Boeing and Douglas DC-8 jets will cover all major traffic points on the airline's system. During the peak trans-atlantic season this summer, all but a few extra section services will be operated with 707-320s or DC-8s.

Pan American's jet fleet at the end of 1959 totaled six 120s and 15 Intercontinental 320s. First DC-8 deliveries have begun, and by the end of 1960 Pan American's fleet is expected to include 29 Boeings and about 15 DC-8s, or a total of 44 jets.

Pan American thus has a long lead in the jet competition, but other contenders are moving up. Trans World Airlines, busy breaking in its Boeing 707-120s on domestic routes, waited until October to inaugurate transatlantic service with Intercontinentals. Qantas Empire Airways of Australia offered some low frequency 707-120 jet schedules on the Atlantic last year as part of its round-the-world services and expects to expand jet operation during 1960.

Several other foreign flag airlines already are on the North Atlantic with jets this year. By the end of 1960, according to the estimate of International Air Transport Assn. President Sir William Hildred, airlines of the world will have received a total of 300 new jet aircraft.

Pan American's traffic which fell off in 1958 in all divisions except the Atlantic, was up 11% in 1959 with a total of 3,219,273 passengers. Revenue passenger miles due to good load factors on long haul jet routes, rose 18%. Transatlantic traffic was up 22% to 335,759 passengers, the Latin American Division carried 1,436,000 passengers, a 13% increase, and on the Pacific the total was up 31% to 414,000 passengers, with the big increase in Hawaii business.

Systemwide, Pan American expects a 25% increase in passengers during this year.

TWA's international traffic was up 9% to a total of 347,410 passengers. Passenger miles rose 15.8% to 1,066,259,000. On the North Atlantic, TWA offered 225,674 seats, and carried 145,587 passengers.

Two U.S. carriers—Braniff and Panagra—will join Pan American as jet operators to South America this year, Braniff with the 707-227 and Panagra with the DC-8. Braniff's South American operation last year showed a 47% in-

PAN AMERICAN Boeing 707-320 jet transport ground crew (above) prepares to run up engines and taxi out from hangar area at New York International Airport. In background is blast fence for engine runup protection. Crewman in left foreground wears noise helmet and holds telephone line to communicate with cockpit for taxi direction. Below, a Pan American jet is fueled by two hoses connected under the wing.

crease over 1958's total of 46,548 passengers. The airline increased its available seat miles by 18%, replacing mixed DC-6 and DC-7C service with an all DC-7C South American fleet.

Panagra, whose 1958 traffic between the U. S. and South America was down to 128,776 passengers, came back with a 15% increase last year in passengers and cargo. DC-8 service from New York and Miami to Panama, Lima and Buenos Aires is expected to begin in May.

Delta Air Lines' international traffic slipped in 1959 for the second straight year. The 1959 passenger total was 47,651, down from 57,037 in 1958. Revenue passenger miles on the international routes dropped from 67,903,636 to 60,022,261. Sharp reduction in Caribbean tourist and business travel because of political upsets, the airline says, has forced a curtailment of services.

Even with the cutback, Delta incurred a loss last year in these services. However, restoration of normal services and introduction of jets will be undertaken "when circumstances permit," according to President C. E. Woolman, who foresees a great economic growth potential for the area.

Eastern Air Lines last year experienced an increase in all international operations except Bermuda. Mexico traffic was up 22.7% to 24,473 passengers; San Juan, up 27.3% to 162,385 passengers; Montreal, up 51.3% to 86,360 passengers; and Ottawa, up 1.7% to 4,876 passengers. The Bermuda total of 21,242 passengers represented a 21% decrease due in part to increased competition and lack of hotel space.

Eastern has put Lockheed Electra turboprops into service on its Montreal and San Juan routes. Jet service with DC-8s between New York and San Juan is planned for this spring.

Mexican Market

In the Mexican market, American Airlines carried 115,000 passengers last year, up from 103,000 in 1958. Competition and route restrictions, according to American, have forced the airline out of several Mexican markets and it is now confined mostly to the Midwest. A daily nonstop DC-7 coach schedule is offered between Chicago and Mexico City, and other flights make stops.

National Airlines increased its Cuban traffic from 51,433 to 75,640 passengers despite the political tensions in that country last year. The business held up well until late September, according to the airline. In 1959, National operated two daily nonstops from New York to Havana, plus schedules from Florida points, and used its top equipment—Electras and DC-6Bs and 7Bs—in the service.

This year, however, schedules have been cut to three a week from New York and frequencies from Florida have been reduced. National says it is ready to add more schedules when tourists start going back to Cuba.

Total air travel market between the U. S. and foreign countries increased 20% to 4,063,964 passengers during the year ended June 30, 1959, according to Bureau of Immigration and Naturalization figures. This rise more than compensated for a decline in the rate of increase during the previous like period from 15% to 11%.

But the U. S. flag air carriers' share of the total continued its slow decline, falling from 60% to 58% of all U. S. arrivals and departures by air to and from foreign countries (the figures exclude Canadian travel over land borders).

Airplanes flying the British flag accounted for 338,066 of these passengers. Cuban flag traffic totaled 203,605 passengers, the Netherlands 159,290 passengers, the three Scandinavian countries, 126,502 passengers, and France, 116,642 passengers, to list the five largest foreign flag totals.

Air travel between the U. S. and Europe accounted for 1,464,816 of the total passengers. Foreign flag carriers hauled 742,252 of these passengers in and out of the U. S., while U. S. flag carriers handled the other 722,564.

Sea travel fared slightly better during the year ending June 30, 1959 than it had during the previous period, when it had experienced a decline. Total of U. S. arrivals and departures by sea carrier during the later period was 1,426,502, up from 1,219,550.

Foreign flag airlines moved during 1959 to strengthen their competitive positions with U. S. carriers by fighting for wider traffic rights under their governments' bilateral agreements with this country. A new bilateral was signed with France after that country had threatened a renunciation of the previous agreement. In a compromise between what France sought and the U. S. was prepared to grant, Air France gained a polar route between Paris and Los Angeles and plans to begin jet service on the route this year.

French routes also were extended from Tahiti to the West Coast via Honolulu, which will allow the French Transports Aeriens Intercontinentaux to connect with Air France in a round-the-world service.

In another bilateral struggle, British Overseas Airways Corp. won approval of a Tokyo stop in London-New York-San Francisco-Honolulu-Tokyo-Hong Kong service. BOAC is operating the route with Bristol Britannia turboprops which connect at Tokyo with a de Havilland Comet 4 jet service from London.

U. S. and foreign flag carriers faced an open rate situation on the North Atlantic after their IATA traffic conference last fall deadlocked without setting many fares for the coming year. A special meeting is expected to produce a compromise that will cover the North Atlantic, but not routes to the Far East and Africa.

BOAC, refusing to maintain existing fare levels for another year and seeking drastic reductions, led the British Commonwealth carriers in a stand that blocked the conference.

The conference, which closed fares only for routes in the Middle East, Europe and North and South America, did agree on new cargo rate structures on the Atlantic and the Pacific. The new rates offer bulk discounts.

Pan American predicted that the new cargo rates would double its Pacific business and considerably increase its Atlantic cargo carriage.

The airline's 1959 cargo ton mileage totaled 116,000,000, an increase of 15% over 1958. Pan American expects a 35% increase in cargo ton miles this year.

ARGENTINE TRANSCONTINENTAL BRITANNIA

U.S. Local Service Airlines

SELECTED OPERATING STATISTICS YEAR 1959

	Rev Plane Miles (000)	Rev Passenger Miles (000)	Passengers: Originating	Passengers: Enplaned	Average Passenger Load	Passenger Load Factor (%)	Total Rev Ton Miles (000)	Ton Mile Util (%)	Ave Rev Load (Tons)	Performance Factor (%)	Revenue Hours	Off-Op Speed	No of Departures	Ave. Length of Haul (Miles)	Daily Aircraft Utilization
Allegheny	6,816	98,878	562,040	577,106	14.5	47.3	13,190	46.4	1.49	93.9	44,672	123.8	79,853	85.4	5.04
Bonanza	4,455	55,894	328,574	233,047	12.5	45.1	8,541	44.8	1.34	99.2	36,338	149.9	35,678	124.3	5.30
Central	4,162	32,334	165,629	171,813	7.9	37.1	3,379	33.8	0.81	98.5	28,340	146.8	51,905	83.2	5.19
Frontier	8,990	78,304	306,676	343,698	8.0	38.4	8,735	44.1	0.98	98.1	58,872	151.5	93,168	95.6	6.26
Lake Central	3,446	36,194	227,183	230,610	10.2	41.5	3,733	45.1	1.08	97.1	34,751	139.3	49,836	78.3	6.01
Mohawk	5,706	109,862	580,260	808,583	16.2	54.8	11,031	54.9	1.93	95.8	36,544	158.2	55,563	103.1	5.10
North Central	13,559	159,852	911,916	957,136	11.8	44.7	16,722	45.8	1.32	97.2	93,219	145.3	161,858	84.2	7.15
Ozark	8,544	93,860	539,062	547,883	11.0	43.9	9,741	46.5	1.14	98.3	59,553	143.2	97,305	87.8	6.48
Pacific	6,810	104,878	466,238	491,606	17.4	54.4	10,233	52.9	1.72	98.3	35,765	148.3	64,565	93.1	4.27
Piedmont	8,064	102,483	480,913	522,630	12.7	45.3	10,363	46.0	1.38	98.6	70,238	160.5	92,268	97.3	4.56
Southern	4,009	45,593	255,639	258,188	9.5	36.6	4,793	37.5	1.98	97.3	23,302	144.8	37,147	84.3	5.23
Trans-Texas	7,338	67,218	263,588	298,387	9.2	39.9	7,210	41.0	0.98	98.2	46,805	159.5	83,157	89.2	5.17
West Coast	5,336	72,021	342,589	412,864	13.5	45.0	7,160	44.7	1.34	97.4	54,628	123.8	86,187	90.5	4.45
Total/Average	87,145	1,057,134	5,338,706	5,649,324	12.1	44.9	128,911	45.7	1.25	97.2	573,663	153.3	985,986	88.4	5.39

Growing Local Carriers Face Cost Bulge

By Robert H. Cook

Washington—Broad expansion of local service airlines' equipment and route programs last year served to accent the concern of the industry for a subsidy formula tailored to meet the needs of the carriers' growth rate.

A gain of more than 29% in route miles, plus replacement of more than 25% of the industry's DC-3 fleet, combined to produce a 25.8% gain in total operating revenues for the airlines, but had the end result of boosting 1959 operating expenses by 30.2% and breakeven need by 29.7% as compared with the previous year. Justifying a subsidy bill of $40 million for 1959, which is estimated to be $1.6 million short of their breakeven needs for the year, plus this year's estimated payments of $51,000,000 will be given top priority by the airlines, since last year's growth pattern will probably be duplicated this year.

Indicative of the heavy expense involved in such growth are Civil Aeronautics Board figures which show that value of the local service carriers' flight equipment jumped from $89.7 million in 1958 to $40.2 million last year. Investment in buildings and ground equipment rose from $3.3 million to $4.5 million for last year, with an attendant debt/equity ratio rise from the $10.1 million for long term debt and $13.6 million for stockholders' equity of 1958 to last year's new high of $31.1 million debt to $15.5 of equity. Working capital for these carriers increased during this period from only $700,000 to $1,900,000.

Results for Year

Preliminary estimates submitted by the carriers for 1959 show:

- Total operating revenues have increased from $94,953,000 in 1958 to a new high of $119,653,021 last year.
- Total operating expenses of $121,244,384 for 1959, which is 30.2% above the $93,336,000 expense figure for the previous year.
- Net operating loss for the industry of $1,591,363 compared with a $1,617,000 profit for 1958.
- Mail and subsidy payments increased by 17.5% with a 1959 total of $41,104,967, compared with $34,110,000 for the previous year.
- Breakeven need, the difference between operating expenses and non-mail revenue, increased by an estimated $9,637,000, or 29.7% above the $32,493,000 breakeven need of 1958.
- Load factor average dropped 1.4% from the 1958 average of 46.3% to 44.9%, for 1959, reflecting a 29.5% gain in available seat miles of 2,365,000 for last year as compared with 1,825,700 miles in 1958.

In retrospect, 1959 was a year of record growth at record cost for the local service operators, who are quick to point out that the heavy expense of operating 10,583 mi. of new routes, along with the integration of new aircraft, was clearly expected to increase the local service airline subsidy bill—a point consistently emphasized by Civil Aeronautics Board members.

How Costs Grow

Indicative of the effect new route mileage exerts on subsidy payments and how the total bill may climb even higher, is the Seven States Area Case ruling which became effective last February. CAB estimates the cost of new services provided by this increased mileage will account for $5.7 million in annual subsidy, or 12% of the local service subsidy estimated for 1960.

Other awards made by the Board last year in the South Central Area, Pacific Northwest Local Service, Montana Local Service, Northeastern, and Southeastern States Area Cases can be expected to account for even greater subsidy increases. Still pending before the CAB are decisions in the Great Lakes Local Service, Kansas-Oklahoma, Piedmont, and Pacific Southwest Cases.

These airlines acknowledge their subsidy bill will increase until they can successfully phase in new and more economical equipment, build traffic volumes on their routes and gain more operational freedom from government regulations. But they feel their public

BONANZA Air Lines and Pacific Airlines F-27s stand on ramp at Los Angeles with United Convair.

OZARK Airlines F-27 frames new terminal at St Louis

benefits in the past 10 years have fully justified the costs In 1949, the carriers say, subsidy accounted for 66% of their earnings as compared to only 33% last year During this period passengers carried rose from fewer than 700 000 to a high of 5,706,000 by the end of 1959, and cities served climbed from fewer than 340 to 488, of which 300 count on local service airlines for their only regularly scheduled airline passenger, mail and cargo service

Besides acquiring new routes and aircraft, the carriers made a significant financial gain through CAB's decision to permit the inclusion of interest charges on long term debt along with break-even need for computation of temporary mail rates An acute problem in the past, this matter became a particularly imposing burden with the purchase of large numbers of new aircraft, spurred by passage of the Guaranteed Loan Act

Examples of the value of including interest charges under subsidy are such cases as the temporary mail rates granted Bonanza Air Lines to include

$320,671 in interest charges for past and future periods of operation and Frontier Airlines, which was authorized $119,430 CAB turned down $402 655 in interest charges requested by Frontier on grounds that payment of the full sum might result in an overpayment when final mail rates are set for the carrier CAB adoption of the new policy results in savings by the airlines since they are no longer forced to borrow funds for interest charges in today's tight money market, the carriers report.

Major value of the interest charge payment is best seen in relation to the Guaranteed Loan Act, which is accounting for a large portion of local service long term debt. CAB has approved guarantees for six of 13 local service carriers, two carriers providing local service in Alaska and Hawaii and a metropolitan helicopter operation Total loan amount of these purchases will exceed $25 million with annual interest charges averaging 5.5% payable on a 7-to 10 year schedule Three other carriers Allegheny, Lake Central and West Coast airlines, who have arranged private financing for new equipment, will also benefit from CAB's payment of interest charges Additional applications are pending from Alaska Airlines and Hawaiian Airlines, Ltd

Guarantee Change

The airlines have welcomed the maximum $5 million guarantee provided by the Act, but they have shelved any plans to urge that it be extended to $10 million this year until they can compile enough accurate operational data on the new aircraft, which include an array of Fairchild F-27s, Martins and Convairs Some of the latter will be Napier-Eland turboprop conversions ordered by Allegheny and Allison engine conversions ordered by Lake Central

Implementation of the loan guarantee also brought strong criticism of the carriers' financial structure from both outside lending sources and the CAB Bankers usually consider a debt equity ratio of one to one as a maximum limit of bank credit, but CAB found its guarantees resulted in pushing this ratio as high as 78 to 22 in such applications as Bonanza and North Central Though approving the guarantees, the Board warned consistently that the carriers must improve their equity balance Bonanza complied with the request as did Aloha and Ozark by offering stock for sale to broaden its equity base

Last year also saw some progress made towards a higher rate of return on investment for the local service operators Pending completion of the Rate of Return for Local Service Carriers Case, CAB permitted an interim raise in the rate from 8% to 9.5%

Later a Board examiner's recom-

PIEDMONT Airlines F-27 is parked in front of terminal at Winston-Salem, N. C.

REVENUES AND EXPENSES YEAR ENDING SEPT 30, 1959

	Operating Revenues				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-mail	Mail and Subsidy	Total		
Allegheny	6,821,892	7,255,028	3,015,549	10,270,577	10,729,563	(458,986)
Bonanza	3,406,546	3,614,721	1,968,243	5,586,964	5,764,973	(178,009)
Central	2,334,440	2,435,732	2,839,518	5,365,348	5,234,989	30,351
Frontier	4,859,844	5,474,564	4,425,072	9,901,636	10,301,308	(399,672)
Lake Central	3,558,537	3,693,159	1,843,618	4,536,768	4,239,957	296,811
Mohawk	7,959,722	8,411,423	2,758,276	11,169,699	10,059,363	1,110,437
North Central	10,714,000	11,480,474	4,634,030	16,116,484	16,531,950	(455,466)
Ozark	6,471,451	6,972,860	2,978,111	9,955,974	9,727,940	328,034
Pacific	5,503,015	6,343,566	3,553,669	9,796,037	9,304,086	493,151
Piedmont	7,380,644	7,990,304	3,084,400	11,074,704	11,159,201	(84,497)
Southern	3,235,380	3,498,931	2,449,325	5,948,256	5,777,751	170,505
Trans-Texas	4,335,385	4,499,483	3,271,334	7,770,718	7,233,971	536,747
West Coast	3,999,597	4,179,730	3,381,436	6,561,166	7,954,650	(1,393,498)
Totals	68,374,395	74,952,768	38,801,657	113,954,417	113,039,601	(65,184)

ALOHA Airlines and Wien Alaska Airlines both operate F-27s in their new states

Local Service Airlines

Preliminary or Estimated Financial Results Year 1959

	OPERATING REVENUES				Total Operating Expense	Operating Profit (or Loss)
	Passenger	Total Non-Mail	Mail and Subsidy	Total		
Allegheny	$7,221,578	$7,516,124	$3,058,263	$10,575,419	$11,261,366	($685,977)
Bonanza	3,694,145	2,819,579	2,196,576	6,316,155	6,242,369	(126,216)
Central	2,261,292	2,482,882	2,836,249	5,319,131	5,409,054	(89,923)
Frontier	5,304,331	5,998,161	4,952,992	10,952,862	11,678,571	(725,708)
Lake Central	2,632,867	2,771,856	1,845,404	4,617,410	4,410,194	207,216
Mohawk	8,240,968	8,764,063	2,074,885	10,840,148	10,671,386	168,762
North Central	11,288,125	12,162,832	6,160,259	18,322,891	18,162,024	161,845
Ozark	6,794,425	7,269,298	3,168,174	10,437,472	10,429,442	8,029
Pacific	5,532,161	6,396,179	2,280,265	8,776,444	8,429,204	337,240
Piedmont	7,269,795	8,016,605	3,184,920	11,201,525	11,721,298	(519,873)
Southern	3,246,267	3,518,885	2,456,856	5,974,941	6,125,946	(151,007)
Trans-Texas	4,430,880	4,895,922	3,071,238	7,967,160	7,628,128	229,032
West Coast	4,624,462	4,822,768	3,718,538	8,551,244	9,055,227	(503,983)
Totals	$72,854,486	$78,548,854	$41,104,967	$119,853,021	$121,244,284	($1,391,263)

EARNINGS HISTORY

	Total Operating Revenues (Includes mail pay)	Total Operating Expenses	Net Operating Income	Net Profit (or loss) After Taxes and Interest
1949	21,418	21,871	(453)	(1,451)
1950	27,870	27,208	664	(588)
1951	36,741	35,993	802	202
1952	42,379	43,497	(1,116)	(488)
1953	49,358	50,903	(1,545)	(2,033)
1954	54,715	53,105	1,610	958
1955	57,450	56,764	686	352
1956	67,712	68,293	(581)	(801)
1957	82,139	82,900	(760)	(1,153)
1958	94,934	93,277	1,657	1,109

Local Service Aircraft

(4th Quarter, 1959)

Carrier	DC-3s	Convairs	Martins	F-27/F-27As	Total
Allegheny	10	12[1]	13		35
Bonanza	10			10[1]	20
Central	15				15
Frontier	25	4			29
Lake Central	12	5[1]			17
Mohawk	7	11			18
North Central	32	5			37
Ozark	24			3	27
Pacific	10		7	6	23
Piedmont	21			8	29
Southern	17				17
Trans-Texas	24				24
West Coast	14			6	20
Totals	221	37	20	33	311

[1] Includes aircraft on order

mendation called for a 12.5% return as "fair and reasonable" and which the airlines point out is very close to the 14% return they feel should be adopted under an operating margin formula.

Nearly two years ago the airlines opposed the idea of a return based upon investment. They held their weak financial condition would deteriorate even further because the shrinking value of their primarily DC-3 equipped fleets would make any return based on investment almost negligible. CAB attorneys countered that measures being taken to aid the airlines, such as the Guaranteed Loan Act, retention of capital gains and route expansions, would double their investment bases by mid 1960. The carriers replied that the depreciation scales of the new equipment would largely nullify any gain in investment base and that with equipment fully depreciated at a residual value of only 15%, the airlines would find themselves in much the same financial position as when they started. The case is now in the final hearing stage before the CAB.

Speculation on outcome of the case has been influenced by recent pressure from the Administration level to hold the line on the mounting subsidy bill. Informed observers say this pressure, which has already resulted in CAB action to draft new, more stringent, subsidy legislation at the request of the Bureau of the Budget, might influence Board members to reject, or at least delay, action on any proposal which could add to the subsidy bill at this time.

'Class Rate' Reverse

Lending some credence to this theory, observers point out, was the surprise move made by CAB in January in shelving its own "class rate" formula for subsidy. With few exceptions local service airlines looked forward to adoption of the new plan as a good replacement for the much disputed rate of return on investment formula. Regarded by the carriers as the first plan with enough economic practicality to free them eventually from subsidy, the proposal set forth definite subsidy standards based on daily round trip schedules of six flights on certain route segments, plus added features of station subsidy, allowances and profit sharing between the Federal government and the airlines.

CAB served notice on the airlines that it would place the flight schedule limitations into effect by March 1, and would continue its study of the overall "class rate" formula. Adoption of the full plan would probably have caused a subsidy increase, but later would have resulted in a decrease, spokesmen said, as carriers were permitted to exercise greater management judgment denied them under present regulations. In general, the airlines view the Board's action on this matter as arbitrary adoption of the "subsidy control" features of the "class rate" plan without any of the incentive benefits it offered.

Basing their opinion upon the Board's statement that it would not abandon consideration of the plan and CAB's willingness to defend its statutory authority to distribute subsidy in a manner to best serve the public interest most observers felt any move to cut or limit subsidy appropriations would not get very far.

Typical of the strong Congressional support enjoyed by local service operators is the Seven States Area Case which added 43 additional cities to the route systems of three local service airlines. Seventeen members of Congress appeared before the CAB in support of new airline service in this case alone.

In this vein, the CAB also commented in its annual report that while withdrawal of low traffic volume routes from the local system would lower subsidy, the number of routes withdrawn would be so heavy it would make the entire local service philosophy an "empty gesture."

Carriers' Study

The airlines are not ignoring the fiscal storm warnings and are taking concrete steps to prove the value of their services and justification of subsidy appropriations. Through the Association of Local Transport Airlines they are now working out the final details of a special study of their operations made by Planning Research Corp., of Los Angeles, Calif. The report generally makes a case that while subsidy has increased it has been surpassed by the growth rate and expanded service provided. It also calls for a lifting of many operating restrictions and a lengthening of flight segments as a means of controlling or lowering the total bill. A major recommendation calls for local service airlines to receive a greater share of interline fares to reflect the cost of originating passengers. The carriers estimate they would gain an additional $3 million in revenue if originating airlines were first refunded a sum sufficient to cover the cost of sales, reservations and ticketing costs, after which the balance would be divided among the various airlines that may have carried the passenger on their routes subsequently.

Strong promise of a practical means of lowering subsidy may come from adoption of an "all up" mail program envisioned by the U.S. Post Office Department. Basic idea of the plan, now being discussed before Congress, would permit the airlift of first class mail on a space available basis at rates about one half of airmail rates. Post Office officials have not estimated the volume such mail carriage may attain in the future and are waiting for CAB agreement on the suggested rates. Some trunklines disagree over this proposal, but local service carriers support the idea and estimate they could probably quadruple their present service mail if the plan is implemented under the proposed rates. Last year the local service post office mail payments totaled more than $1.5 million.

In the meantime, local service operators are looking for new ways to attract greater traffic and are watching with interest the introduction in October by Allegheny Airlines of a new commuter fare with in flight ticketing. Ticket cost between Philadelphia and Pittsburgh on a Convair 540 turboprop transport was set at $13.20, compared to $20.30 for pre ticketed passengers and holding confirmed reservations. CAB approved the plan as in keeping with Board philosophy that carriers should seek new revenue sources and directed that Allegheny submit a detailed resume of the monthly results of the cost and profit.

COMPARISON OF OPERATING STATISTICS

	1958	1959	INCREASE 59/58 Amount	Per cent
Revenue Plane Miles (000)	73,555	87,145	13,590	18.5
Revenue Passenger Miles (000)	844,372	1,057,134	212,762	25.2
Originating Passengers	4,333,038	5,328,708	995,668	23.0
Enplaned Passengers	4,583,856	5,649,324	1,065,888	23.2
U. S. Mail Ton Miles	1,720,595	2,199,332	478,737	27.8
Express and Freight Ton Miles	4,055,695	5,335,125	1,279,430	31.5
Average Passenger Load (Persons)	11.5	12.1	0.6	5.2
Passenger Load Factor (%)	46.3	44.9	(1.4)	—
Total Revenue Ton Miles (000)	86,590	108,911	22,321	25.8
Ton Mile Utilization (%)	46.7	45.7	(1.0)	—
Average Revenue Load (Tons)	1.18	1.25	0.07	5.9
Performance Factor (%)	97.5	97.2	(0.3)	—
Revenue Hours	499,820	572,063	72,243	14.5
Off-ramp Speed (m.p.h.)	147.2	152.3	5.1	3.5
Number of Departures	863,774	985,986	122,212	14.1
Average Length of Hop (Miles)	85.2	86.4	3.2	3.8
Daily Aircraft Utilization	5:55	5:39	(0:16)	(4.5)
Average Length of Journey:				
Originating Pssgr.	195	198	3	1.5
Enplaned Pssgr.	184	187	3	1.6
As of Fourth Quarter:				
Number of Aircraft	247	294	47	19.0
Number of Employees	9,325	11,440	2,115	22.7
Number of Stations	426	488	62	14.6
Route Miles Operated	35,885	46,468	10,583	29.5

BONANZA F-27 is serviced at Phoenix as TWA Constellation taxis out.

PAN AMERICAN DC-7 CARGO CONVERSION

Carriers Skirmish for Role in Air Cargo

Washington—Air cargo plans to penetrate a new, mass market and signs of congressional encouragement overshadowed its actual record of performance in gaining tonnage last year.

Air cargo has begun to erase its reputation as a stepchild of passenger service and to sell itself as an asset to general business on business terms, to prove that its rate of growth is handicapped primarily by lack of special aircraft designed for cargo, and to win recognition that the lack of such fleets may limit military airlift capabilities in the event of a national crisis.

Concrete recognition of air cargo's needs, strength and growth potential came about last year in these developments:

- **Growth** in freight, mail and express revenue ton miles.
- **Plans** by several domestic and international trunks to convert passenger aircraft to all-cargo use.
- **Additional trunkline** plans to acquire newly designed all cargo planes.
- **New aircraft orders** by two all-cargo operators.
- **Post Office** proposal for an "all up" mail program.
- **Increased manufacturer** interest in the design of new turboprop and turbojet cargo planes.
- **Signing** of a new Air Express agreement.
- **Preparation of Congressional** legislation to permit the Civil Aeronautics Board to guarantee loans for the purchase of new cargo aircraft.

Combined industry revenue ton miles for mail were up more than 13% last year to 124,696,000 miles, for express to 56,480,000 miles for an increase of 14% over 1958, and for freight to 553,880,000 for a gain of more than 15% over the previous year. Total industry revenue cargo ton miles of more than 735 million reflected a gain of nearly 16% over the 1958 total.

Trunkline recognition of the air cargo market potential was underlined last year by American Airlines' $4.25 million contract to convert 10 DC-7 passenger planes to all-cargo configuration. First of the modified aircraft were put into cargo service by the end of October and four more were added by the end of the year, which saw a 10% gain in total cargo revenue ton miles realized by the airline.

During the year, Pan American World Airways experienced a 15% gain in its system cargo ton mileage and announced plans for the conversion for cargo of 10 DC-7C airliners. United realized a 9% gain on cargo ton mileage for its system in 1959 and will convert 6 DC-7s to cargo use.

Trans World Airlines also converted 8 Super Constellations to cargo use last year. Eastern Airlines revealed similar plans for the conversion of 5 Super C Constellations.

Action also was taken by both trunkline and all cargo carriers to purchase new aircraft specifically designed for economical cargo operations. Early options by Pan American World Airways and Slick, an all-cargo carrier, for the Lockheed CL-207 Super Hercules were canceled when military support for development costs on which the contracts were contingent was not realized. The airlines later followed the lead of Flying Tiger Line, which earlier placed an order for 10 Canadair CL-44D swing tail cargo aircraft, the first of which are scheduled for delivery early this year. Slick ordered 10 of the Canadian aircraft and Seaboard and Western has placed orders for 5 CL-44s.

Signing of the Flying Tiger order is of twofold interest to the industry since the loan is being insured in part by the Canadian government, and joint research to formulate a new air freight tariff tailored to the expected economical advantages of the CL-44 is now under way between Canadair and the airline.

The primary target of the $200,000 study will be development of a domestic rate which may be as low as 6 cents a ton mile to the shipper. Average rate is expected to run about 13 cents a ton mile compared to present rates of 18 and 19 cents.

While the CL-44 is the only off the shelf cargo plane now available in the 40,000 lb. payload class, many airlines consider it solely as an interim aircraft pending the development of turbojet cargo carriers with higher load capacity and speed.

Industry selection of a cargo designed aircraft ties in closely with Department of Defense studies on a new cargo plane to modernize the Military Air Transport Service and Congressional legislation introduced recently by Sen. A. S. Mike Monroney (D-Okla.), asking Civil Aeronautics Board authority to guarantee loans of up to $85 million for airline purchase of cargo aircraft and ground support items. The bill also directs all government departments and agencies to increase the amount of routine government air cargo traffic to commercial carriers.

Prerequisite for a loan guarantee

Air Cargo in Scheduled Service 1958-1959

	THOUSANDS OF REVENUE TON-MILES					
	Mail		Express		Freight	
	1959	1958	1959	1958	1959	1958
DOMESTIC TRUNK LINES						
American	22,549	20,249	10,531	9,608	100,571	91,178
United	31,281	31,132	11,978	11,025	74,103	66,984
Trans World	17,593	13,677	8,944	7 065	32,130	24,018
Eastern	12,490	11,240	6,183	5,336	17,026	13,803
Northwest	7 195	5,829	3,213	2,828	16,153	11,125
Delta	5,051	5,190	3,577	3,270	15,266	12,801
Braniff	4,171	3,914	2,184	2,056	7,803	6,705
National	2,822	3,849	580	721	7,055	6,233
Capital	5,927	5,703	3,225	2,809	4,689	3,772
Western	3,596	2,130	1,081	708	3,847	2,397
Continental	1,585	1,207	834	543	2,605	1,969
Northeast	1,257	1,108	471	372	1,352	1,175
Total Trunk	116,517	104 953	53,101	46,267	282,600	241,886
LOCAL SERVICE LINES	1,930	1,721	2,210	1 802	3,125	2,253
ALL CARGO LINES						
AAXICO[a]						
Aerovias Sud Americana					7,005	8 106
Flying Tiger	619	473	826	481	123,600	104,073
Riddle	106	340	331	377	38,322	58,595
Seaboard & Western	5,524	1,772			34,795	19,315
Slick		76		43	30,111	4,440
Total Cargo	6 249	2,723	1 169	1,112	268,155	234,894

[a] Not Available

would be approval of the aircraft selected for purchase by both the Department of Defense and the Federal Aviation Agency

All cargo operators and combination carriers alike are split on the need for such legislation, with American, Eastern Pan American and the Flying Tiger Line opposing the bill against National, Northwest Aerovias Sud Americana Slick Airways and members of the Independent Airlines Assn

Key to eventual outcome of the legislation lies with the Department of Defense, which is expected to make known its preference for a new cargo plane in the near future

Tension Buildup

Buildup of tension between the airlines, manufacturers and the government, over which type aircraft may be selected, hit a new peak last month when FAA Administrator E R Quesada told Congress that the CL-44 is the only existing aircraft which meets both the operational cost and performance requirements outlined by Defense Department and FAA.

At the same time, Lockheed Aircraft Corp announced it is surveying the airline market as a preliminary step toward redesigning its C 133B Super Hercules cargo aircraft, offered last year to the airlines and the Air Force The company said the new design contemplates the use of Rolls Royce Tyne turboprop engines which also power the CL 44

Boeing Airplane Co produced the results of study on air cargo by Prof Stanley Brewer of the University of Washington Brewer's evaluation of MATS cargo aircraft needs noted that Boeing's proposed swing tail cargo turbofan, the Boeing 735, can operate at a lower work unit cost than an existing cargo plane He termed the pure jet cargo plane and the C-133B as the most profitable airplanes in terms of marginal revenue

American Airlines earlier gave strong support to the eventual purchase of Boeing's turbofan 735 or cargo versions of the Douglas DC-8 The airline told a CAB examiner in the Domestic Cargo-Mail Service Case that three sets of specifications for the Lockheed Super Hercules and revisions on the Canadair CL-44D failed to meet American's needs, but that the manufacturers were continuing to refine their proposals

Also mentioned last year in the cargo aircraft field was the British made Armstrong Whitworth Argosy which has been discussed by both AAXICO and Riddle airlines Vickers is working on a swing nose version of the VC 10.

While much of the air cargo industry's 1959 progress can be measured only in initial planning steps, the industry gained an important revenue advantage in the signing of a new five year contract with the Railway Express Agency Terms of the new "Air Express' agreement, signed last September provide a greater incentive for both parties, the airlines say, with the agency and the airlines sharing equally in risk and benefits Under the old contract provisions the airlines were held responsible for all line haul operations and the agency for collection and delivery Both parties also now have an equal voice in setting the air express rates and signing of the agreement has been given credit for much of the increased air express revenue realized by the airlines last year

Raytheon Pattern

Growing recognition of the advantages of shipping by air is expected to expand this year in a pattern similar to that announced recently by the Raytheon Co's Distributor Products Division, involving the routine use of air freight with automated order and inventory handling

Renault, Inc manufacturer of the French Renault automobile, has been flying replacement parts for its cars in this country since late 1958 and has airlifted about 900 tons of replacement parts in 90 chartered flights since then

Boeing Airplane Co, which now receives jet engines for its Boeing 707 series aircraft by air has estimated that it saved shipping costs of $750,000 on the engines for the first 100 Boeing 707s assembled through reduced packaging costs involved

Cargo airlines and combination carriers also look for heavy gains in both transatlantic and transpacific air shipping as a result of rate reductions scheduled to go into effect this year. The first cut in Pacific rates was voted by the International Air Transport Assn, last fall and provides generally lower rates on a more liberal system of weight classifications

Pan American estimates its Orient shipments will double this year as a direct result of the new rates

Transatlantic rates will be reduced from 30-36% on a large variety of commodities by April 1 At the same time, the airlines point out, maritime shippers have announced a rate increase for the transatlantic service

Consideration of the U S Post Office Department's "all up" mail program this year also holds great promise for cargo carriers once the proper shipping rates can be determined

U.S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIERS, DOMESTIC & INTERNATIONAL AS OF DEC 31, 1959

	Douglas					Vbcount		Lockheed				Convair				Martin		Boeing		Fairchild	Curtiss	Grumman	Totals
OPERATOR	DC-8	DC-7*	DC-6†	DC-4	DC-3	V810	V745	188	1649	1649A	736 040	540	640	340	240	404	202	707	377	F 27	646*	G-21	
Allegheny					10							1					12						23
American		31	82					29							34			24					199
Bonanza					9															6			15
Braniff		8	10		8			7					6	26				1			8		66
Capital				10	11		9				11												41
Caribbean Atlantic					7																		7
Central					10																		10
Continental		8			10	10												4					34
Delta	8	21	10		10									26							8		83
Eastern		42	7	1				40		32	19		20			56							220
Frontier					25									9									34
Lake Central					12																		12
Mackey				3	2																		1
Mohawk					9								4		5								28
National		8	12					12		4			8	8				24					67
North Central					32									9									37
Northeast			18		11		10																39
Northwest		17	23	10				9											9				67
Ozark					34																		34
Pacific					9												5		8				22
Panagra		8	4	1	4																		18
Pan American		26	46	23														19	15				129
Piedmont					17															8				25
Resort				9																			9
Southern					16																		16
Trans-Texas					29																		29
Trans World								39		44	69					69		19					160
United	18	53	80										42										194
West Coast					14															8			22
Western			27					5							5								37
Cargo Lines																							
Aaxico																					33		33
Aerovias Sud Americana				1																	3		4
Flying Tiger										14											1		15
Riddle				3																	11		14
Seaboard & Western				3	1					9											1		14
Slick			3	10						3													16
Operation Mixed (Cargo Lines)																							
Alaska Airlines			3	2										1							3		9
Alaska Coastal																						7	7
Alpha					1															3			10
Caribair					2																2		4
Ellis																						8	8
Hawaiian			1		8									5									14
Northern Consolidated																				8			8
Pacific Northern					3					6													9
Reeve Aleutian				2	2																1		5
Wien Alaska					1															2	8		7
Total: All Domestic and International Aircraft	18	220	325	82	305	10	87	69	28	109	104	1	36	122	46	85	18	68	21	34	33	15	1 827

* DC-7 -7B -7C † DC-6, -6A, -6B ‡ C184B, 1049C 1049D, 1049G 1049H § 640, GW20T
‡ The two Boeing 707s used by National on this table are leased from Pan American World Airways & are included in Pan American's total
Compiled by AVIATION WEEK from figures supplied by Federal Aviation Agency's Statistics Division, Office of Management Services

Lack of Funds Slows Airport Expansion

By Ford Eastman

Washington—Airport modernization and expansion programs, already hard pressed to keep pace with the growth in air travel, will fall even farther behind during 1960 unless legislation is enacted in this Congressional session to prevent a slackening of construction.

The problem facing airport operators is not readily apparent to those outside the construction field because it involves the long lead time necessary for planning airport projects before funds are actually obligated, a span ranging from three to six months.

The airport aid program, extended by Congress last year, comes to an end on July 1, 1961. A new airport aid program, therefore, could not be passed during the next session in time to permit the planning of projects so that funds could be obligated when they become available on July 1.

Last year for example, the Federal Airport Aid Act extending aid for two years at $63 million annually became a law on June 29, one day before the end of Fiscal 1959. Allocation of the funds made available was not completed until November. As a result, airport operators claimed that almost a year of potential construction was lost because they could not determine how much money would be available or how it would be apportioned geographically.

Although Fiscal 1961 federal airport aid funds will not become available until July 1 of this year, allocation of the money is scheduled for the beginning of this month so that project planning can take place before funds become available.

The only chance of preventing delays in the airport programs, operators contend, is to convince Congress that there is an urgent need for action during the current session, despite its crowded calendar.

But aviation backers in both the House and Senate are not planning any major aviation legislation for consideration this year. They have told the industry publicly not to expect such action.

Industry representatives, however, are saying that they would prefer to wait until next year before seeking necessary legislation not only because of the crowded Congressional schedule but also because of the current Administration's attitude on many bills that call for increased federal expenditures.

Last year, for example, the Senate amended and passed a bill introduced by Sen. A. S. Mike Monroney (D-Okla.) authorizing $465 million in federal aid to match state and local funds for airport projects during the next four years. Threat of a presidential veto reduced this to $63 million a year for two years in conference committee.

Earlier, the Administration had said that the government should begin withdrawing from the airport aid program, leaving it to the states and local communities.

On the other hand, surveys have shown that when commercial jet transports were introduced on domestic routes, very few airports were prepared to handle them with maximum efficiency. Very few are fully prepared today, although considerable headway has been made.

At the present time, there are only 18 cities in the U.S. that can accommodate the new jet transports. By the end of this year, another 17 cities should provide the jets with sufficient runways to land and take off.

Neglected areas where considerable amounts of money must be spent in the near future, airport operators contend, include parking ramps, turnoffs from runways, holding pads and baggage handling facilities.

A Federal Aviation Agency survey of 3,000 airports pointing out desirable improvements showed that more than $1 billion would be needed from Fiscal 1959 through Fiscal 1962 to meet jet requirements and to provide parking lots, cocktail lounges, night clubs, theaters, private clubs, garages, hotel rooms, commercial offices or gamerooms—facilities for which the present law specifically prohibits the use of federal funds on a matching basis.

Since federal matching grants amount to only $126 million for a two year period, instead of the $250 million desired by the industry, local fund requirements must be doubled in order to keep the modernization and expansion program on schedule.

This is unlikely because local communities, outside of the biggest metropolitan areas, often encounter serious difficulties in attempting even to match federal funds. If they are not matched, the federal funds are withheld and the planned projects must wait.

Nevertheless, state and local governments provide more money for airport improvements than does the federal government even though contributions supposedly are made on a 50-50 basis. Nationally, federal participation ranges from 20 to 30% of total funds and on a major project in a metropolitan area federal participation can be as low as 5%.

A major reason for this is that only so much federal money is available. Since requirements are usually more than twice the matching funds, the remainder must be raised locally.

AREA	Total Needs	Fiscal 1959 Allocations	Fiscal 1960 Allocations
Alabama	$22,063,000	$1,308,261	$595,830
Alaska	37,771,000	1,957,877	2,400,686
Arizona	22,354,000	773,399	1,042,373
Arkansas	5,515,000	566,649	279,100
California	200,994,000	6,593,422	6,169,737
Colorado	30,308,000	300,627	1,033,955
Connecticut	12,503,000	250,000	797,095
Delaware	2,993,000		152,075
Florida	17,723,000	1,832,878	1,332,427
Georgia	22,581,000	2,861,250	721,538
Hawaii	19,890,000	2,875,000	1,000,000
Idaho	5,954,000	423,546	199,393
Illinois	92,815,000	5,315,414	2,350,583
Indiana	10,351,000	1,227,300	634,652
Iowa	9,308,000	1,836,555	351,026
Kansas	12,595,000	387,047	19,865
Kentucky	23,785,000	858,063	1,486,697
Louisiana	35,129,000	2,219,257	2,639,110
Maine	9,817,000	254,600	278,250
Maryland	29,236,000	942,864	330,883
Massachusetts	42,486,000	720,660	973,236
Michigan	26,112,000	2,339,420	2,324,150
Minnesota	23,289,000	1,750,000	1,581,788
Mississippi	19,408,000	1,174,611	1,044,817
Missouri	25,830,000	2,629,162	929,000
Montana	9,888,000	109,591	46,080
Nebraska	15,761,000	1,153,079	752,350
Nevada	6,165,000	999,945	95,576
New Hampshire	5,051,000	20,190	37,750
New Jersey	30,112,000	723,000	592,200
New Mexico	14,312,000	410,340	405,130
New York	106,776,000	1,613,306	4,333,450
North Carolina	13,039,000	1,822,351	948,092
North Dakota	5,466,000	143,989	
Ohio	35,483,000	1,628,519	2,432,059
Oklahoma	21,934,000	1,938,871	2,164,277
Oregon	9,659,000	195,938	481,145
Pennsylvania	80,764,000	6,918,974	3,783,637
Rhode Island	4,488,000		143,925
South Carolina	9,144,000	182,503	136,000
South Dakota	6,937,000	116,534	74,843
Tennessee	19,110,000	1,813,915	1,327,749
Texas	42,563,000	3,568,522	3,199,468
Utah	8,026,000	2,159,777	956,410
Vermont	4,669,000	237,000	35,750
Virginia	16,186,000	896,699	452,000
Washington	18,095,000	1,147,081	1,270,661
West Virginia	10,861,000	384,638	449,071
Wisconsin	23,132,000	1,430,750	1,471,572
Wyoming	5,444,000	578,416	125,227
Puerto Rico	10,113,000		441,500
Virgin Islands	5,705,000	1,060,500	197,944
Totals	$1,299,695,000	$72,452,290	$57,022,252

For Fiscal 1960, the FAA listed 288 projects in the states and territories that would receive a total of $57,076,702 in federal aid. State and local matching funds would bring the total amount of expenditures for the year to $114,163,404, as compared with the $250 million needed annually under the four-year program to meet requirements.

Of the $57 million programmed in federal aid, $21.6 million, or 38%, is allocated for runway construction, $19.4 million, or 34.1%, for taxiways and aprons, $9.5 million, or 16.7%, for land acquisition, and the remainder for lighting marking, construction of control towers, clearing and obstruction removal fencing, and roads and buildings other than control towers.

In addition to federal money for airport construction, the FAA has requested $654 million for Fiscal 1961, of which a large portion will go to cover the cost of air traffic and the expansion of navigation facilities. These include 13 airport control towers, short range aviation units (Vortac) at 62 locations, 20 instrument landing systems, approach lighting for 89 airports, long range radar facilities and air traffic radar beacons at 27 locations for en route traffic, and 27 terminal area traffic control radar beacons.

AEROFLOT Tu-114 turboprop transport stands on taxiway at New York International Airport at Idlewild as a Braniff Airways Lockheed Electra taxis in the foreground

Aeroflot Expands Traffic, Jet Experience

Moscow—Russian civil air transportation turned its emphasis from jet-age showmanship to solid progress during 1959 as it chalked up record traffic gains but made the fewest flashy headlines in several years.

No impressive new Soviet transports were unveiled, and the astronomic—if largely meaningless—percentage gains in passengers carried continued to recede. Yet Aeroflot handled more business with greater efficiency than ever before as four-turboprop Il-18s and An-10s and 100-passenger, twin jet Tu-104Bs began to share trunkline duties with high-cost Tu-104s and Tu-104As.

The state-owned Russian airline claimed a 48% increase in passengers flown during 1959, against a 56% jump in 1958 and 69% in 1957. Even so, the numerical gain in passengers handled last year—approximately 3 million—was well ahead of increases registered in any previous 12-month period.

Aeroflot had another reason for satisfaction. The USSR's Central Statistical Administration reported that the government's air passenger goal was exceeded by 6% in 1959. This means that the Soviet airline monopoly is ahead of schedule in its program to expand passenger air travel six fold under the nation's Seven-Year Economic Plan (1959-1965).

Total Traffic

Total traffic on Russia's domestic and international routes in 1959 is estimated unofficially at 10-11 million passengers, compared with more than 55 million for all U.S. scheduled airlines. American carriers, while showing a far smaller percentage gain than Aeroflot, flew 6.5 million more passengers in 1959 than in 1958.

The Russian airline opened fewer major international routes during 1959 than in the glamor-packed period following inauguration of its first scheduled jet operations in September 1956. On the other hand, it upgraded and expanded service on domestic runs at an unprecedented rate.

By the end of 1959, Tu-104s, Il-18s and An-10s were serving almost 30% of Aeroflot's domestic trunkline route mileage.

Operating under a new chief, Colonel-General Evgeny F. Logunov, Aeroflot's most publicized achievements last year were the numerous flights by jets and turboprops from Moscow to the United States.

At one time during Premier Khrushchev's U.S. visit the shuttling of courier Tu-104s between the Russian and American capitals was tantamount to a scheduled operation.

The huge turboprop Tu-114 carrying Khrushchev flew from Moscow to Washington in 12 hr. nonstop and from Washington to Moscow in 10½ hr., thereby justifying performance claims made for the airplane when it was first unveiled in November, 1957. A later transatlantic flight by an An-10 bearing gifts from Khrushchev to President Eisenhower was regarded by the Soviet press as an unofficial proving run to demonstrate its ability to provide regular USSR-U.S. service at a later date.

Tu-114s, Tu-104Bs and Il-18s were actively engaged during 1959 in making non-scheduled, prestige building flights from Moscow to other parts of the world.

Il-18s flew to such distant points as Mexico City, Baghdad and the African republic of Guinea. A Tu-104B participated in a Canadian air parade at Toronto. Tu-114s, besides visiting New York and Washington, made appearances in Budapest, Paris, Peking and Tirana, Albania.

Record Flights

Both the 80- to 95-passenger Il-18 and the 100-passenger Tu-104B set world records during 1959.

An Il-18 carrying 15 metric tons flew a 2,000-kilometer closed course at an average speed of 447 mph. On another flight it lifted a 20 metric ton payload to an altitude of 39,370 ft. A Tu-104B carried a 25 metric ton payload to an altitude of 42,310 ft.

It also flew 15 tons over a 1,000-kilometer closed course at a speed of 631 mph.

Aeroflot officials have confidently predicted another banner year for Russian air transport during 1960. They expect the number of persons carried by jets

AEROFLOT AN-10A IN U S

and turboprops alone to double in the 12-month period

In January of this year, Il-18s were placed in scheduled service on the 3,500-mi trans-Siberian run from Moscow to Yakutsk, giving the aircraft their first real test as reliable long-haul transports. About the same time, Il-18s were introduced on the Moscow-Bucharest-Sofia route and made a non-stop proving run from Moscow to Cairo.

New Turbine Routes

An-10s, whose scheduled passenger service last year was confined largely to the Ukraine and western Russia, will be used in Siberia during 1960 on the Irkutsk-Yakutsk, Novosibirsk-Alma Ata, and Khabarovsk-Magadan routes. Tu-104Bs, which inaugurated commuter-type flights between Moscow and Leningrad in April 1959—skyrocketing traffic on the short-haul run 1,000% in six months—will make longer trips from both points to the Crimea this year.

Jets or turboprops will replace piston-powered craft on at least a dozen routes radiating from Moscow alone before the end of the summer. These will include runs to such northerly points as Murmansk and Norilsk, both well above the Arctic Circle.

A significant move will be to "double track" the existing trans-Siberian route, which now extends from Moscow through Sverdlovsk, Orsk, Novosibirsk, Krasnoyarsk and Irkutsk to Khabarovsk and Vladivostok, and is sometimes shut down during the winter for days at a time by bad weather. The alternate link, scheduled to open on a full-time basis this spring after several delays, runs north of the present line but will have several interlinking "corridors." Thus planes on either track can shift north or south to bypass socked-in airports.

Many large Russian cities soon will get new direct service to distant points in the USSR via jets or turboprops. Indirect routings through Moscow and time-wasting layovers at connecting points will be sharply reduced.

As the larger planes take over the trunk routes, twin-engine, piston-powered Il-14s, Il-12s and Li-2s are being assigned to provincial links in impressive numbers. With more equipment available for local runs, Russia says that air transportation in some provinces is now so common that Aeroflot generates one passenger per inhabitant per year. Although turbine-powered transports and long-haul services grab most of the attention, Aeroflot still flies "almost half" of its passengers on local routes.

Aeroflot officials have promised that the four turboprop Tu-114—the world's largest commercial transport—will go into regular service during the second quarter of 1960. The Russians expect the Tu-114 to fly from Moscow to Vladivostok (5,000 mi.) and from Moscow to Petropavlovsk, Kamchatka, (5,500 mi.) nonstop.

Delays in putting the Tu-114 into scheduled operation have caused considerable comment. The Rossiya (Russia) was slated to begin service by last summer, carrying 220 passengers in its tourist version, 170 passengers in the standard configuration, and 120 passengers in the intercontinental version. Recent reports indicated that the Tu-114 still had technical troubles involving the gear boxes that transmit power from the 12,000 shp. engines to the contrarotating, 18-ft. propellers.

Another Tupolev transport—the Tu-124—is likely to share the spotlight with the Tu-114 in 1960. Initial references described the Tu-124 as a medium-range aircraft with more-powerful, new-type engines designed by P. A. Soloviev, who developed the turbine engines for the Mi-6, the world's largest helicopter. The Tu-124 is destined for "wide use" on Soviet airlines.

In Aeroflot's international operations, turboprops will replace piston-engine Il-14s this summer on the Moscow-Vienna, Moscow-Stockholm, Moscow-Berlin and Moscow-Helsinki routes. Frequency of existing jet service from the Soviet capital to Peking, New Delhi and Copenhagen will be increased.

Helicopter Service

Expansion of Aeroflot's passenger helicopter services is certain to be one of the main developments in Russian commercial aviation during 1960. The Soviet carrier has announced plans to open over 100 helicopter routes covering more than 6,210 mi. in the Russian Soviet Federated Socialist Republic alone this year.

In the summer of 1959, ten-passenger, single-rotor Mi-4s, operating in the vacation areas of the Crimea and along the Caucasus Black Sea coast, carried over 100,000 persons. New links will be opened in these areas as well as in the Far East, Central Asia, Siberia and the Far North.

Moscow "in the near future" will have "salon-type" six-passenger Mi-4s shuttling from its downtown area to the three capital airports, Vnukovo, Bykovo and Sheremetyevo. Other important Soviet cities slated for helicopter routes include Perm (formerly Molotov), Irkutsk, Sverdlovsk, Chita, Krasnoyarsk, Tomsk, Kemerovo, Novosibirsk and Petropavlovsk, Kamchatka.

Russia's ambitious program for developing helicopter passenger transportation was implemented last December with the first public display of the twin-rotor Yak-24K "Flying Bus." A commercial version of the military's Yak-24 "Horse," the new craft has a range of 248-621 mi., payload capacity of 8,820 lb., and top speed of 112 mph. De luxe version will carry eight passengers and a guide, while less pretentious configurations will accommodate 20-30 persons. Aiding the Yak-24K and Mi-4 in passenger operations will be the coaxial Ka-18 and single-rotor Mi-1, both capable of carrying four persons.

Russia concedes that the continued rapid expansion of its air transportation system has brought on a wide variety of growing pains. Pilots particularly have complained that "ground services have lagged behind advances in the air."

Long delays in putting the Il-18 in regular trans-Siberian service stirred accusations that the turboprop was being treated like "an unwanted child." Passengers, who never had such good airline service before, are making increasing demands for even better treatment. Some have gone so far as to seek refunds when flights are not on time.

According to a Russian newspaper reporter, "We Soviet citizens have become accustomed to speed. After flying in a Tu-104 just once we don't want to get aboard a piston-powered plane, let alone a train. And if, while en route from one end of the country to the other, we are held up for even one day, we let fire at the airline with a stream of recriminations."

Terminal Improvements Planned

Heeding the complaints, Gen. Loginov promised that airport and airway improvements scheduled under the Seven-Year Plan would be rushed to completion. Last year, he pointed out, Moscow opened its third airport—Sheremetyevo. Other cities such as Kiev and Novosibirsk have received second fields to accommodate increasing traffic volume.

"The airport terminal buildings we have planned in our country will in no way be inferior to those abroad, and in some cases will be superior to them," Gen. Loginov said. "They will be well equipped, and each will be able to serve several tens of thousands of persons every 24 hr."

In January, Loginov announced that construction would start "in the very near future" on a new terminal at Moscow's Vnukovo Airport that will accommodate an additional 2,000 persons. Later, a separate international terminal with its own runways and "equipment with the last word in technology" will be built across the Kiev highway. "In a few years," Loginov promised, "it will be difficult to recognize Vnukovo Airport."

As a further improvement to the Soviet capital's ground services, Aeroflot plans to start construction this year on its new downtown passenger terminal, which will provide complete information, ticketing and through-checking of baggage. From this terminal, passengers will be taken to one of the city's three airports by bus or helicopter.

Major construction is also planned this year at Novosibirsk, Khabarovsk, Irkutsk, Vladivostok and "dozens of other" Soviet airports. Large appropriations have been made for improved airway and landing aids, weather reporting service and repair bases, especially along the trans-Siberian route.

TRANS-CANADA AIR LINES DOUGLAS DC-8

World Airlines Race to Fill Jet Seats

The year 1959 was one of preparation for most of the world's international airlines as they waited to receive the first units of their fleets of turbojets.

With the extension of turbojet and turboprop services over medium and short haul routes in many countries, the piston airplane was fast fading from the prime traffic segments. With mass deliveries of the long-range Boeing and Douglas jet transports, the race to fill new levels of capacity in the high-speed aircraft will be under way this year.

Some highlights of airline activities around the world as the industry moves into the full-scale age of jets include:

Australia

Qantas Empire Airways introduced Boeing 707-120 jet service on its round-the-world route last September and plans to increase frequency of service this year.

Australian international air service route miles increased from 59,390 to 62,365 during the year ended June 30, 1959. International passengers embarked totaled 90,659, up from 84,624. Seat capacity was up 12.2%, load factor down 3.2% to 57.7%. Passengers embarked in domestic service rose from 2,151,613 to 2,265,872. Available seat miles were up 3.8% and load factor was up from 61.5% to 62.3%.

Trans-Australia Airlines carried 960,643 passengers during 1959, a 12% increase.

Belgium

Sabena Belgian World Airlines received the first of five Boeing 707-320 jet transports on Dec. 21, 1959, and on Jan. 24 became the first foreign-flag airline to operate the big jets in trans-atlantic service. The airline also is serving Leopoldville and Johannesburg with the jets. By April 1, Sabena's transatlantic fleet will be all-jet and during the peak season this year it will offer 17 weekly schedules from New York to Brussels.

New York-Moscow service is scheduled this summer with the 707-320s. Flight time will be less than 12 hr.

Sabena has ordered four Sud Aviation Mark 6 Caravelles, first order of the advanced version of the French jet. The aircraft will be delivered next year.

During 1959 the airline carried its 250,000th passenger in the six year old helicopter service.

During the year Sabena became a member of Air Union—the association of four national airlines in Europe. Other developments included additional sales offices in Europe, the Mideast and Africa, and expansion of its African routes.

Canada

Canadian Pacific Airlines, taking advantage of a new government policy breaking Trans-Canada Air Lines' monopoly on transcontinental routes, last May began service between Vancouver and Montreal via Winnipeg and Toronto. Canadian Pacific put its 89 passenger Bristol Britannia turboprop transports on the route, competing with Trans-Canada Super Constellations.

Both of the big Canadian carriers have ordered Douglas DC-8s powered by Rolls-Royce Conway engines. Trans-Canada planned to put its first jets into transcontinental service this month and to begin transatlantic jet service in April. Canadian Pacific will not get its first jets until late 1960 or early 1961.

Trans-Canada carried 3,209,197 revenue passengers last year, up from 2,785,523 in 1958. Load factor was 66%, down from 69.3%. Other developments included inauguration of weekly service between Montreal and Vienna and extension of its Canadian and U.S. Vickers Viscount turboprop services. The airline was granted an extension of Boston-Halifax service to New York.

During 1959, Trans-Canada added four Viscounts to its fleet for a total of 49, added a 13th Super Constellation, and ordered a $3.5 million reservations system for 1961 delivery.

Canadian Pacific planned to begin Montreal-Rome service via Lisbon this month, with the hope of extending this route to Bangkok and Hong Kong for a round the world service if governmental agreements could be made.

Canadian commercial aviation generally showed the effects of the new government policy designed to increase competition and turn more government work over to the commercial carriers. Freer granting of licenses to charter operators included operators of large helicopters and non-scheduled elements. Commercial services were expanded in Canada's northland. Ice reconnaissance in the Arctic during 1959 was performed entirely by commercial carriers, and they also are providing airlift support to the U.S. Air Force in the Newfoundland-Labrador area.

Earnings of scheduled Canadian carriers for the first nine months of 1959 totaled $142,289,000 on gross operating revenues, up from $124,289,000 during the same period of 1958. Rising expenses, however, held the net operating income to $3,110,000, compared with $2,580,000 for the first nine months of 1958.

France

Air France has begun transatlantic jet service with Boeing 707-320 equipment between New York and Paris. In April, the carrier plans to begin polar route service from Los Angeles with the jets and to open jet service from Chicago the same month. At that point Air France's transatlantic services will be all-jet.

Jet service over Air France's Paris-Anchorage-Tokyo route was inaugurated Feb. 16 with weekly schedules. Shorter-haul routes in Europe the Near East, and Africa increasingly are being served by the Sud Caravelle jet. The airline carried more than 150,000 Caravelle passengers from opening of service last May through December, 1959.

Air France carried about 3 million passengers system wide last year and flew 2,268,110,000 passenger-miles.

Renegotiated bilateral agreement with the U.S. gave Air France its polar route and extended the route of Transports Aeriens Intercontinentaux from Tahiti to the West Coast via Honolulu, linking the French carrier with Air France in a round the-world route. TAI has ordered two DC-8s and Union Aeromaritime de Transport, France's largest private airline, has ordered another two.

Germany

Lufthansa German Airlines increased its system wide traffic by 26% for a 1959 total of 692,400 passengers, but expects a deficit for the year of about $10 million, biggest loss since its post war resumption of service. Competition on the North Atlantic by early jet operators, cabotage position, and South American service fare reductions were among the reasons cited for the poor financial showing.

Lufthansa plans to inaugurate its own jet services this month with New York-Frankfurt flights, operating the Boeing 707-420, of which the airline has ordered five. In May, Lufthansa plans to activate its San Francisco-Europe polar route with jet service and to fly transatlantic jet flights from Chicago. Its European services will be handled by Viscounts and Convair 440s. Four Boeing 720 medium range jets are on order for delivery next spring and will be used on Middle East and South Atlantic runs. Its 1649A Super Constellations now on the North Atlantic will be shifted to Far East service.

Lufthansa's system passenger load factor in 1959 was 53.5%, up from 53.2%. The airline carried 68,000 North Atlantic passengers last year, up from 54,413 in 1958. System wide freight business was up 44% and mail carriage up 29%.

Great Britain

British Overseas Airways Corp. extended its de Havilland Comet 4 service over many routes during 1959 and early 1960.

The airline's Boeing 707-420s required several modifications and transatlantic service with these jets, originally set for early 1960, now is expected to begin in April.

The BOAC Comets are now flying to all six continents, flying Montreal-London and New York-London, from London through the Near East, India, Hong Kong and Tokyo, to Australia and South Africa from London from New York to Nassau and Jamaica, and from London to South America. At Tokyo, the Comet flights link up with BOAC Bristol Britannia turboprops which cross the Pacific to San Francisco and continue to New York.

British European Airways plans to begin service in April with its first pure jet, the Comet 4B, over its London-Moscow route. First deliveries of its Vickers Vanguard turboprops are expected in April and the aircraft will go into high density service to the continent in July.

BEA's net profit for 1959 was about $5,600,000 after a 5% payment on capital to the British government. Traffic was up 20%. Airline inaugurated London-Moscow service last April and has experienced a load factor of about 58% on the route with its Vickers Viscounts, which will be replaced by the Comets, making the service nonstop. By next fall, the last of BEA's Douglas DC-3s will be phased out and its equipment will be entirely turbine-powered.

Among the developments expected this year in BEA's operation is formation of a consortium arrangement with Olympic Airways of Greece. This will cover several Mediterranean routes and will involve the use of three of each carrier's Comet 4Bs.

With a new lower fare structure going into effect in Europe this year, BEA expects another 20% increase in traffic over its routes.

Holland

KLM Royal Dutch Airlines will enter transatlantic jet competition April 9

MEXICANA DE AVIATION S.A. COMET 4C

with weekly Douglas DC-8 service between New York and Amsterdam. The Dutch airline has ordered 12 of the jets, will increase to daily schedules on April 25. KLM also ordered 12 Lockheed Electras, most of which went into service last year.

India

Air India plans to make its debut in transatlantic service May 14 with the inauguration of Boeing 707-420 service between New York and India. Deliveries already have begun of Air India's order of four 420s.

Initial transatlantic schedules will total three weekly in each direction over two routes: New York-London-Paris-Rome-Cairo-Bombay and New York-London-Frankfurt-Geneva-Beirut-Bombay-Calcutta.

Italy

Alitalia continued to expand in 1959, its second full year of operation after merging with LAI. New services last year included Rome-Karachi-Bombay and New York-London. On the North Atlantic, passengers totaled 45,371, up from 26,425 in 1958. Cargo on the route was up 129% to 1,685,725 lb.

During 1959, Alitalia became a member of the four-airline Air Union.

The Italian carrier expects delivery of the first six Rolls-Royce Conway-powered Douglas DC-8s in April, with transatlantic service starting in June. First service with the Sud Aviation twin-jet Caravelle is scheduled to begin in May. Alitalia has ordered eight of the French jets, which will be used in European and Mideast services. The airline's DC-7Cs will be phased off the North Atlantic and will serve such routes as South America and Africa.

Service between Montreal and Italy will be inaugurated this month, and other routes will be extended to include Prague, Cairo and Amsterdam.

Alitalia expanded its sales offices in the U.S. during 1959, opened offices in Montreal and Toronto, and enlarged passenger facilities at New York International Airport.

Gross revenues before taxes for 1959 totaled $56 million.

Scandinavia

Scandinavian Airlines System has scheduled its inaugural trans-Atlantic DC-8 service for May 1 between New York and Copenhagen. By October, units of the seven-plane DC-8 fleet will be operating over the airline's U.S. West Coast-Europe polar route and over its Copenhagen-Anchorage-Tokyo polar route.

SAS has put six Caravelles of a total order of 11 in service and has carried more than 80,000 passengers in the French jets since inauguration of service last April.

Two Convair 600s also have been ordered by SAS. The carrier's present fleet includes 14 DC-7Cs and 20 Convair 440s in addition to its jets.

SAS gross revenues during the year ending last Sept. 30 totaled $106.7 million, an increase of $1.2 million. Passengers carried during that period totaled 1,590,000.

Spain

Iberia Airlines of Spain has placed an order for three Douglas DC-8s and hopes to inaugurate transatlantic jet service late this year. The airline presently flies Lockheed Super C Constellations between Madrid-New York-South America.

South America

Two South American carriers have introduced jet service to the United States. Aerolineas Argentinas, the Argentine state airline, put de Havilland Comet 4s in service between Buenos Aires and New York and on a South Atlantic route to Europe. Varig Airlines of Brazil flies Sud Aviation Caravelles between New York and Rio de Janeiro and Sao Paulo.

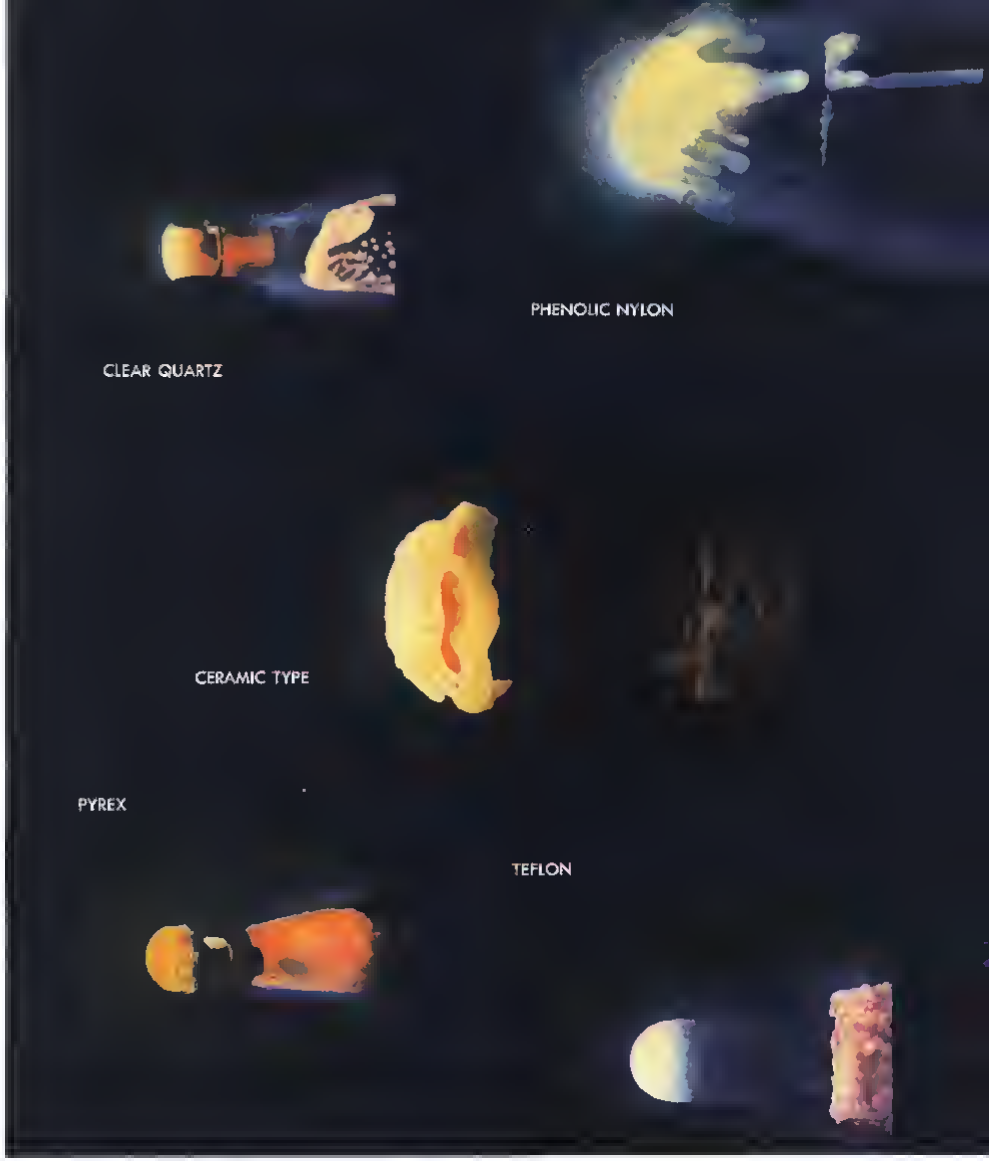
Transcontinental S.A., the Argentine private enterprise airline, has dropped its order for four Convair 880 jets, which had been scheduled for 1961 delivery. Real Airlines of Brazil has reduced its order of four 880s to three. Delivery is scheduled in July, 1961. Varig's order of two Boeing 707-420s is firm and delivery is expected in July, 1960. Panair do Brasil has ordered four DC-8s for delivery this year.

Japan

Japan Air Lines expects to offer trans-pacific jet service in DC-8 equipment by late summer, serving San Francisco, Los Angeles and Seattle on the U.S. West Coast. The airline has ordered five DC-8s.

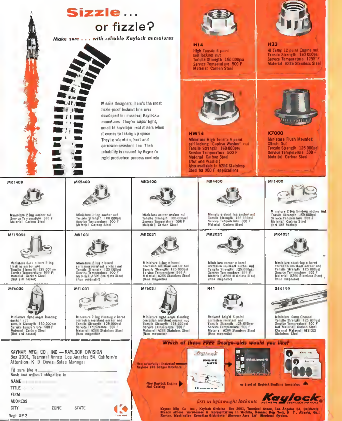
JAL expanded its services last year, adding the Seattle and Los Angeles points to its route and opening new routes in the Far East. The carrier operates nine weekly round trips between Tokyo and the U.S. with DC-7C and DC-6B equipment.

Last month an agreement was concluded with Air France for joint operation with JAL over the polar route from Europe to Japan. Under the agreement, Air France 707-320s will carry JAL insignia as well as its own. Japanese stewardesses will also be used. When the Japanese airline's own DC-8s go on the route in the spring of 1961, the two carriers will operate under a pool agreement with revenues shared on a prorated basis. A similar arrangement will apply later on the southern route between Japan and Paris or London. This pool service will probably begin in late 1961 or early 1962.



Nose cone ablation materials undergo test in arc wind tunnel at Avco Research Laboratory. Ceramic-type material (center) was used on the first Thor Able nose cone recovered successfully after re-entry.

Specifications



U. S. Military Aircraft

Manufacturer	BASIC AIRCRAFT DATA			DIMENSIONS					WEIGHTS			POWERPLANT
	Military designation	Military name	Primary mission	Number in crew	Over-all span	Over-all length	Over-all height, ft-in.	Gross wing area, sq ft	Weight empty, lb	Normal gross wt., lb	Maximum gross wt., lb	Number, make, model and max. rating, ea
Beech Aircraft Corp *Wichita Kansas*	T-34A	Mentor	Trainer	2	32 8	25 0	10'	177 6	2 155	2 950	2 950	1 Co O-470-13 @ 225 h.p.
	T-34B	Mentor	Trainer	2	32 8	26 0	10'	177 6	2 254	2 985	2 985	1 Co O-470-13 @ 225 h.p.
	L-23D	Seminole	Liaison Transport	1-2	45 3	31 6	11 4	277	4 160	7 000	7 000	2 Ly GSO-480-B1B6 @ 340 h
	RL-23D		Radar Recon	2	45 3'	31 11	11 4	293 9	5 354	7 350	7 350	2 Ly GSO-480-B1B6 @ 340 h
	L-23F		Liaison Transport	1 2	45 3'	33 3	14 1	277	4 740	7 700	7 700	2 Ly IGSO-480-A1A6 @ 340 h
Boeing Airplane Co *Seattle Wash.*	B-47E	Stratojet	Med. Bomber	3	116	107	28'				200 000	6 GE J47-GE-25 @ 6 000 lb t
	B-52A	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		350 000+		8 P&W J57-P-1W @ 10 000+ lb
	B-52B	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		350 000+		8 P&W J57-P-1W @ 10 000+ lb
	B-52C	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		390 000+		8 P&W J57-P-19W @ 10 000+
	B-52D	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		390 000+		8 P&W J57-P-19W @ 10 000+
	B-52E	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		390 000+		8 P&W J57-P-19W @ 10 000+
	B-52F	Stratofortress	Heavy Bomber	6	185	152 9'	48 3'	4 000		390 000+		8 P&W J57-P-43W @ 10 000+
	B-52G	Stratofortress	Heavy Bomber	6	185	157 7'	40 9'	4 000		450 000+		8 P&W J57-P-43W @ 10 000+
		Dyna-Soar	Recon.-Bomber									
	B-52H		Heavy Bomber									8 P&W JT3D @ 14,000+ lb.t.
Cessna Aircraft Co *Wichita Kansas*	T-37B		Trainer	2	33 10'	29 3'	9 2'	183 9	4 056	6 519	6 600	2 Con J69-T-25 @ 1 025 lb t
	Model 407				36 3'	31 8'	9 4'	200 22	4 558	9 000	9 500	2 Con 356-9A @ 1 400 lb t
Chance Vought Aircraft, Inc. *Dallas Texas*	F8U-1	Crusader I	Day Fighter	1	35 8'	54 3'	15 9'					1 P&W J57-P-4A @ 10 000+ lb
	F8U-1P	Crusader I	Photo-Recon	1	35 8'	54 6'	15 9'					1 P&W J57-P-4A @ 10 000+ lb
	F8U-2	Crusader II	Day Fighter	1	35 8'	54 3'	15 9'					1 P&W J57-P-16 @ 10 000+ lb
	F8U-2N	Crusader II	AW Fighter	1	35 8'	54 3'	15 9'					1 P&W J57-P-20 @ 10 000+ lb
Convair Division General Dynamics Corp. *San Diego Calif*	F-102A	Delta Dagger	AW Interceptor	1	38 1'	68 3'	21 2'					1 P&W J57-P-23 @ 10 000+ lb
	TF-102A		Trainer	2	38 1'	59 7'	20 7'					1 P&W J57-P-23 @ 10 000+ lb
	F-106A	Delta Dart	AW Interceptor	1	38 3'	70 8'	20 3'					1 P&W J75 @ 15,000+ lb t
	T-29D	Flying Classroom	Crew Trainer	4	91 9'	74 8'	27 3'	817	29 000	43 575	43 575	2 P&W R-2800-99W @ 2,500 h
Ft Worth, Tex. Division	B-58	Hustler	Bomber	3	56 10'	96 9'	31 5'	1,542		160 000		4 GE J79 @ 15 000 lb t
	WS-125A		Bomber									Nuclear power (P&W)
Douglas Aircraft Co *Long Beach Calif*	B-66B	Destroyer	Tac. Bomber	3	72 6'	75 2'	23 7'	780	42 000	78 000	83 000	2 All J71-A-11 @ 10 000 lb t
	WB-66D	Destroyer	Weather-Recon	3	72 6'	75 2'	23 7'	780	43 178	79 000	83 000	2 All J71-A-13 @ 10,200 lb t
El Segundo, Calif Div	A3D-2	Skywarrior	Attack	3	72 6'	76 4'	22 9'	780	38 298	70 000		2 P&W J57-P-10 @ 10 500 lb t
	A4D-2N	Skyhawk	Attack	1	27 6'	40 1'	15 2'	260	9 589	16 216		1 Wr J65-W-16A @ 7 700 lb t
	F4D-1	Skyray	Interceptor	1	33 6'	45 8'	13	557	16 021	27 000		1 P&W J57-P-8B @ 10,200 lb
Goodyear Aircraft Corp *Akron Ohio*	ZS2G		ASW Airship	8	[illegible] 6'	285 3'	92 0'	1 556	30 764			2 Wr Mod R-1300-1 800 h.p.
	ZPG-2		ASW Airship	14	75 5'	342 7'	96 8'	2 000	46 722			2 Wr Mod R-1300-2A 800 h.p.
	ZPG-2W		AEW Airship	21	75 5'	342 7'	106 9'	2 000	47 770			2 Wr Mod R-1300-2A 800 h.p.
	ZPG-3W		AEW Airship	21	85 2'	403 5'	117 8'	2 612	71 703			2 Wr Mod R-1820-88 1525 h.p.
	GA-468	Inflatoplane	Recon. Rescue	1		19 8'		110 7'	228		550	42 h.p. Nelson
	GA-466	Inflatoplane	Recon.-Rescue	2		19 3'		151 3'	390		740	60 h.p. McCulloch
Grumman Aircraft Eng'rg. Corp. *Bethpage N Y*	F9F-8T	Cougar	Trainer	2	31 6'	48 0'	12 1'			20 600		1 P&W J48-P-8A @ 7 200 lb t
	F11F-1	Tiger	Interceptor	1	31 8'	40 10'	12 0'	250	13 428	21 174	24 078	1 Wr J65-W-18 @ 10,500 lb t
	F11F-1F	Super Tiger	Interceptor	1	31 8'	40 10'	12 0'	250				1 GE YJ79-GE-3 @ 15,000+ lb
	S2F-1	Tracker	ASW	4	69 8'	42 3'	16 3'					2 Wr R1820-82 @ 1,525 h.p.
	WF-2	Tracer	AEW	4	69 8'	45 4'	16 10'	407				2 Wr R1820 @ 1,525 h.p.
	W2F-1		AEW	5								2 All turboprop
	AO-1AF	Mohawk	Observation	2	42	41	12' 8'	330	7 772		12 000	2 Lyc T53-L-3 @ 1,005 eshp.
	A2F-1		Attack	2								2 P&W J52 @ 7,500 lb t
	S2F-3	Tracker	ASW	4	72 7'	43 6'	16 7'					2 Wr R1820-82 @ 1 525
Lockheed Aircraft Corp *Burbank Calif*	F-104G	Super Starfighter	Interceptor	1	21 11'	54 9'	13 6'					1 GE J79-GE-11A @ 15,000 lb t
	F-104F	Super Starfighter	Fighter Bomber	2	21 11'	54 9'	13 6'					1 GE J79-GE-11A @ 15,000 lb t
	F-104C	Starfighter	Fighter	1	21 11'	54 9'	13 6'					1 GE J79-GE-7 @ 15 000 lb t
	F-104D	Starfighter	Tac. Trainer	2	21 11'	54 9'	13 6'					1 GE J79-GE-7 @ 15,000 lb t
	EC-121D	Warning Star	Radar Picket	31	123' 5'	116 2'	27	1 654				4 Wr R3350 @ 3,250 h.p.
	P2V-7	Neptune	ASW		103'	91 8'	13 0'	1,000	47 150	78 000		2 Wr R3350-32W @ 3 500 h.p.
	Y/P3V-1		ASW	10	99	104 7'	33' 7'	1 300		120 000*		4 All T56-A-10W @ 1 500 eshp
	U-2		Research	1								1 P&W J57 @ 10 000 lb t
The Martin Co *Baltimore Md*		Dyna-Soar	Recon. Bomber									Multi-rockets
	P5M-2	Marlin	ASW	8	118 2'	101	32 8'	1 406	49 686	74 442	85 000	2 Wr R3350-32W @ 3 400 h.p.
McDonnell Aircraft Corp. *St Louis Mo*	F-101A	Voodoo	Fighter-Bomber	1	40	67' 5'	18					2 P&W J57-P-13 @ 10,000+ lb
	RF-101C	Voodoo	Photo-Recon	1	40	69 3'	18					2 P&W J57-P-13 @ 10,000+ lb
	F-101B	Voodoo	Interceptor	2	40		18					2 P&W J57-P-55 @ 10 000+ lb
	F3H-2N	Demon										
	F4H-1	Phantom II	AW Interceptor	2	38' 5'	56						2 GE J79-GE-2 @ 15,000+ lb
North American Aviation Inc. *Los Angeles Calif*	B-70	Valkyrie	Bomber	4							500 000*	6 GE J93 @ 25 000+ lb t
	F-86F	Sabre	Fighter Bomber	1	37 1'	37 6'	11 7'				17 000	1 GE J47-GE-27 @ 5,970 lb t
	F-86H	Sabre	Fighter-Bomber	1	37 1'	38 8'	15					1 GE J73-GE-3 @ 9,000 lb t
	F-86K	Sabre	Interceptor	1	37 1'	40 4'	15			16,500	20 217	1 GE J47-GE-33 @ 5,600 lb t
	F-86L	Sabre	Interceptor	1	37 1'	40 4'	15					1 GE J47-GE-33 @ 7,650+ lb t
	F-100C	Super Sabre	Fighter	1	38	47	15					1 P&W J57-P-7 @ 10,000+ lb
	F-100D	Super Sabre	Fighter Bomber	1	38'	47	15					1 P&W J57-P-21 @ 10 000 lb t
	F-100F	Super Sabre	Fighter-Bomber	2	38	50	16	385 2	21 348	31 235		1 P&W J57 @ 10,000+ lb t
	F-107A		Research	1	36 7'	60 10'	19 8'					1 P&W J75 @ 15,000+ lb t
	X-15		Research	1	22'	50	13	200			31 275	1 RMI XLR-99 @ 50 000+ lb
	T-39	Sabreliner	Utility	2	44 5'	43 8'	15 11'	342 5	9 104	15 330		2 P&W J60 @ 3,000 lb t
Columbus (Ohio) Division	FJ-4B	Fury	Fighter-Bomber	1	39 1'	36 5'	13 11'	338		19 300		1 Wr J65-W-16A @ 7 700 lb t
	A3J-1	Vigilante	AW Attack	2	53	73	20					2 GE J79-GE-2 @ 15 000 lb t
	T2J-1	Buckeye	Trainer	2	37	38 8'	14 9'	255	6 193	8 816	11 373	1 Wr J34-WE-16 @ 3,400 lb t
Northrop Corp *Hawthorne Calif*	T-38A	Talon	Trainer	2	25 3'	44 5'	12 10'		7 200		11 600	2 GE J85-5 @ 3,850 lb t
	N-156F	Freedom Fighter	Fighter	1	25 3'	44 10'	13 2'	171 11	7 848	12 192	16 200	2 GE J85-5 @ 3,850 lb t
Republic Aviation Corp *Farmingdale N Y*	F-105D	Thunderchief	AW Fighter Bomb	1	34 11'	64 3'	19 8'	385	28 000	31 000	46 000	1 P&W J75-P-19 @ 15 000
	F-105B	Thunderchief	Fighter Bomber	1	34 11'	63 1'	19 8'	385				1 P&W J75-P5 @ 20 000+ lb
Temco Aircraft Corp *Dallas Texas*	TT-1	Pinto	Trainer	2	29 10'	30'	10 10'	108	3 139	4 100	4 400	1 Co J69-T-2 @ 920 lb t

	PERFORMANCE						ARMAMENT	CHRONOLOGY				REMARKS
	Normal fuel cap., gal	Maximum speed, mph	Initial rate of climb, fpm	Stall speed, dirty mph	Service ceiling, ft	Combat radius, mi	Number, type and designation	First flight of prototype	First production contract	First deliveries to service	First flight, first production article	
	50	182	1 120	55	18 200		2 x 30 cal mg 8 rockets	Dec 48	Nov '52	Sept. 53	Oct. 53	
	50	188	1 150	58	18 100		2 x 50 cal mg 8 rockets	Dec 48	June '54	Dec '54	Nov 54	
p	230	238	1 580	84	25 600		None		July '56	Dec 56	Nov 56	
p	158	238	1,463	84	23 800		None	Dec 58	Feb 58	Feb 59	Feb 59	
	238	279	1 300	80	27 000		None	Aug 58	June 58	Mar '59	Feb 59	
		600+			40 000+	1 500+	2 x 20 mm cannon 20 000 lb bombs GAM-63 Rascal	Dec 47	Sept 48	Oct 51	June 50	Production discontinued Feb '57
lb t		600+			50 000+			Apr 52	Feb 51	June 54	Aug 54	XB-52 contracted June '46
lb t		600+			50 000+				Dec 52	Nov 55	Jun 56	Also J57-P 29W J57 P 19W
lb t		600+			50 000+				Dec 53	Jan '56	Mar 56	Also J57-P-29W
lb t		600+			50 000+				Dec 54	Nov 56	Sept 56	Also J57-P-29W
lb t		600+			50 000+				May 53	Oct. '57	Oct 57	Also J57-P 29W
lb t		600+			50 000+				Aug 56	June 58	June 58	
lb t.		600+			50 000+		2 NAA GAM-77 Hound Dog		Sept 57	Oct. 58	Oct 58	USAF-NASA joint project.
	321	498	3 260	85	39 700	395	None		Sept 58	Nov 59	Nov 59	
	550	485	3 600	87	46 000	795						
		1 100			50 000		4 x 20mm cannon 32 x 2 75-in rockets	Mar 55	June '53	Mar 57	Sept. 58	Plus 2-4 Sidewinders.
		1 100						Dec 56		Nov 57	Dec 56	
		M<2					4 x 20 mm. cannon 32 x 2 75-in rockets	Dec 57	Dec '57		Aug. '56	Plus 2-4 Sidewinders.
		M<2										2-4 Sidewinders
		M1+			50 000+		GAR-98 Falcons 24 x 2 75-in rockets	Oct. 53				
		M1+			50 000+			Oct 50	Apr 54	Nov '58	Oct. 55	Side-by-side seats.
		M2+			60 000+	800	MB-1 Genie GAR-3 GAR-4	Dec 58				F-106B is tandem two-seater
p.	1,550	500	1,370	92	24 000		None	Sept. 49				
	13000	M2+			50 000+		Varied loads in external pods	Nov '56		Nov '56		Delta wing
	4 800	600+					2 x 20-mm cannon	June 54	Aug. 53	June '55	Jan '55	
	4 489	600+					2 x 20-mm cannon	June 54	May 53	Apr 56	Mar 55	
	4,385	600+					2 x 20-mm cannon	Oct. 52	Feb 51	Mar 56	Sept '53	Also photo., ECM tanker and trainer versions
	800	650+					2 x 20 mm cannon	June '54	Nov 52	Oct. 56		
	640	700+					4 x 20 mm cannon					
2800 rpm								July 54		Apr 56	May 55	*Fixed fin area ruddervator area 765 sq ft
2800 rpm								Mar 53		Oct 53	Nov 53	Fixed fin area ruddervator area 852 sq ft.
2800 rpm								Feb 55		May 55	Dec. 55	Fixed fin area ruddervator area 932 sq ft.
2800 rpm								July 58		June 59	Dec. 59	Fixed fin area ruddervator area 940 sq ft.
	25	72	550	27	13 300			1955		1958	1958	
	16	70	500	43	9 500			1957				
		850+					2 x 20 mm. cannon					First U.S. area-ruled fighter
		M1+					4 x 20 mm cannon					
		1 000+			38 000		4 x 20 mm cannon					
							Sonobuoy depth charges, missiles	Dec. 52				S2F-3
											Dec '60	Large overhead radome
												Overhead radome
		316	3 000		25 000	200						STOL capability
												Low-level attack
							Sonobuoy depth charges missiles, etc.	May 59				
		M2+			70 000+		1 x T-171 Vulcan 2 x Sidewinders	Mar 54	Mar 52	Oct. '60	Sept. 50	Speed record, 1,404 mph altitude 91 243 ft.
		M2+			70 000+		2 x Sidewinders 1 x T-171 Vulcan		Mar 59	Dec. 58	Jan 58	
		M2+			70 000+		1 x T-171 Vulcan 2 x Sidewinders			Oct. 58		
		M2+			70 000+		1 x T-171 Vulcan					
		300*					None			Dec 53		WY-2E is Navy version
+					22 000		6 x 20 mm cannon	May '45		Apr 54		
												Electra re-design
		400+										
					55 000+							Weather recon
	2 815	250	1 200	98	24 000	700	2 x 20 mm cannon 8 rockets	Aug '53	May 52	June 54	Apr 54	USAF-NASA joint program; Navy follow-on award 1/59 French order 2/60
		1 200+			50 000+		4 x 20-mm cannon	Sept. 54	Sept. 52		Sept. 54	Production completed
		1 000+					None					Production completed
		1,000+					GAR-98 Falcons 2 MB-1 Genie					
												Production phase-out in 59
		M2+				1 000	4 Sparrow III plus Sidewinders	May '58				BLC from No 6 onwards
		M<3			70 000+	7 000+						Program cut to 2 prototypes.
		650+			45 000+	592+	6 x 50 cal mg 16 x 5-in HVAR	Apr '53	Dec. '57		Sept. '53	Or 6 x 50 cal. mg
		700			45 000+	1,100	4 x 20 mm cannon	July 54				For NATO
		650+			45 000+	500+	4 x 20 mm cannon					Many F-86D Conversions.
		650+			45 000+			May 53	Mid 53	Sept. 54		
		1 000+			50 000+	600+	4 x 20 mm cannon	Jan 58		Mid 55		
		1 000+			50 000+	900+	4 x 20 mm cannon	Aug. 58	May '56	May 57	Mar 57	Also Fighter Trainer
	1 185	1 000+	20 000		50 000+	1 000+	2 x 20 mm cannon	Sept. 58				To NASA for high speed research.
		1 300+										Design similar to B-70
		2 000			70 000+		None	Sept. 58	Oct '58			Or GE J55
	850	575	5 550	87	30 000+	1,400	None	Jan. 57				
		487	7 500	115	40 000+		4 x 20 mm cannon Sidewinders					
		M2									Aug 58	Boundary layer control Ground level ejection
	381	102	5 000	79	40 000+		2 x 50 cal. mg 14 2 75-in rockets	Jan 58	Sept. 56	July 59	Jan 58	Ground level ejection
		M1 2+			55 000			Apr 58	Dec '58		Jan '60	
		M2+			52 200			July 59				
+ lb t		72			50 000+		1 x Vulcan 20-mm cannon Sidewinder	Oct 55			June 56	Extensive navigation radar fire control system
		M2			50 000+		1 x Vulcan 20-mm cannon Sidewinder	Oct 55		May 58	Apr 58	100 Kilo speed record 1 216 48 mph.
	124	325	1 500	73	40 000	278	None	Mar 56	June '56	Nov 57	Nov 57	Tandem seats.

U.S. Missiles

	GENERAL				STATUS				AIRFRAME					
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Over-all length, less booster, ft	Over-all span, wings or fins, ft	Body diameter, ft	Launching wt., less booster, lb	
Air-to-Air	Eagle	XAAM-N-10	Navy	Bendix	✓	✓			Grumman	—			—	Aeroje
	Falcon	GAR-1, 2, 3, 4, 9, 11	USAF	Hughes			✓	✓	Hughes	6 5	1 8	0 6	100	Thiok
	Genie	MB-1	USAF	Douglas			✓	✓	Douglas	8				Aeroje
	Sidewinder 1A	AAM-N-7	Navy	Philco/G E			✓	✓		9		0 4	158	Naval
	Sidewinder 1C		Navy	Philco		✓	✓							
	Sparrow I	AAM-N-2	Navy	Sperry				✓	Sperry	12			300	Aerojet
	Sparrow III	AAM-N-6	Navy	Raytheon		✓	✓	✓	Raytheon	12	3 3	0 8	350	Aeroje
Air-to-Surface	Bold Orion		USAF		✓				Martin					
	Bullpup	ASM-N-7 GAM-83A	Navy/USAF	Martin			✓	✓	Martin	11	3	1	571	Thiok
	Corvus	XASM-N-8	Navy	Temco		✓			Temco					Thiok
	Crossbow			Northrop		✓								
	Gimlet		Navy		✓	✓								
	Hound Dog	GAM 77	USAF	NAA			✓		NAA	40				P&W
	Quail	GAM 72	USAF	McDonnell			✓		McDonnell	16	7	1 5	1,100	GE
	Rascal	GAM-63	USAF	Bell Aircraft				✓	Bell Aircraft	32		4		Bell A
	Sky Bolt	GAM-87A	USAF	Douglas	✓				Douglas					Aeroje
	Wagtail		USAF	Minn.-Honeywell										
	Zuni		Navy				✓			9		0 4	107	
Anti-Submarine	Able		Navy	Avco			✓	✓		8 8		1 1	500	—
	Asroc		Navy	Minn Honeywell			✓		Minn Honeywell					
	Subroc		Navy	Goodyear	✓	✓			Goodyear					Thiok
Surface-to-Air	Bomarc	IM-99B	USAF	Boeing		✓	✓		Boeing	4 5	18 2	3	15 000	Marq
	Hawk	XM3	Army	Raytheon	✓	✓	✓		Nortronics/Raytheon	16	4	1 2	1 250	Aeroje
	Mauler		Army		✓									
	Nike Ajax		Army	Western Electric				✓	Douglas	21		1		Aeroj
	Nike Hercules	XM6E3	Army	Western Electric			✓	✓	Douglas	27		2 5		Thiok
	Nike Zeus		Army	Western Electric		✓			Douglas					Gr C
	Redeye		Army/USMC	Convair/ARGMA	✓	✓				4		0 25	28	
	Talos	SAM-N-6	Navy	Bendix			✓		McDonnell	28		2 6	6 000	McDo
	Tartar		Navy	Convair		✓	✓		Convair	16		1 0		Arro
	Terrier	SAM-N-7	Navy	Convair			✓	✓	Convair	18		1 0	3 000[1]	Atlan
	Davy Crockett		Army			✓								
Surface-to-Surface	Atlas	SM-65	USAF	Convair		✓	✓	✓	Convair	82		10	250 000[1]	Rocke
	Claw		USAF		✓									
	Slam		USAF	Chance Vought	✓									Marq
	Cobra		USMC	Daystrom	✓	✓	✓		Daystrom	2 9	1 1	0 3	80	
	Corporal	M2	Army	Firestone/Gilfillan			✓	✓	Firestone	46		2 6	12 000	Ryan
	Honest John	M31	Army	Emerson Elec./Douglas			✓	✓	Emerson Elec./Douglas	27	8	2 6	6 000	Herc
		XM50	Army	Emerson Elec./Douglas			✓		Douglas	25	4 8	2		Herc
	Jupiter		Army/USAF	Chrysler			✓	✓	Chrysler	60		9	110 000	Rocke
	Lacrosse	M4E2	Army	Martin			✓	✓	Martin	19	9	1 7	2 300	Thiok
	Little John	XM51	Army	Emerson Elec.		✓	✓	✓	Emerson Elec.	10	2	1		Herc
	Lobber		Army	Convair		✓			Convair	9				
	Mace	TM-76	USAF	Martin			✓	✓	Martin	44	23	4 5	14 500[1]	Alliso
	Matador	TM-61	USAF	Martin				✓	Martin	40	29	4 5	12 000	Alliso
	Minuteman	WS-133A	USAF	Boeing		✓								Thiok
	Pershing		Army	Martin	✓	✓			Martin					Thiok
	Polaris	FBM	Navy	Lockheed		✓	✓		Lockheed	28			28 000	Aeroj
	Redstone		Army	Chrysler			✓	✓	Chrysler	63		6	61 000	Rocke
	Regulus I	SSM-N-8a	Navy	Chance Vought				✓	Chance Vought	33	21		12 000	Allis
	Regulus II	SSM-N-9a	Navy	Chance Vought				✓	Chance Vought	57	20		22 500	GE
	Sergeant		Army	JPL/Sperry		✓	✓		Sperry	30	6	3		Thiok
	Shillelagh		Army	Aeronutronic		✓								
	Snark	SM-62	USAF	Northrop			✓	✓	Northrop	67	42	10	50 000	P&W
	Thor	SM-75	USAF	Douglas			✓	✓	Douglas	62		8	110 000	Rocke
	Titan	SM-68	USAF	Martin	✓	✓	✓		Martin	90		10	222 000	Aeroj

Abbrevi
ABL — Allegany Ballistics Labs
ABMA — Army Ballistic Missile Agency
AC — AC Spark Plug
ADC — Aerophysics Development Corp
APL — Applied Physics Laboratory
Army Ord — Army Ordnance
BuAer — Bureau of Aeronautics
BuOrd — Bureau of Ordnance
FTL — Federal Telecommunications Laboratory
GE — General Electric
GFE — Government furnished equipment
Gr.Central — Grand Ce
ICBM — Intercont
IRBM — Intermedi
JPL — Jet Propu

	POWERPLANT			GUIDANCE		PERFORMANCE		
Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, n. mi	REMARKS
-General	1	spr	—	Bendix	Active radar homing		30+	Long range missile for subsonic aircraft platforms will have nuclear warhead
d	1	spr	—	Hughes	Semi-active homing/infrared			GAR-3 and -4 are advanced versions of GAR-1 and -2 1 and 3 use radar 2 and 4 infrared GAR-9 will have longer range and nuclear capability. GAR-11 was for F-108.
-General	1	spr	—	—	Unguided		1 5	Nuclear warhead guided version under development.
Powder Factory	1	spr	—	Philco/G.E	Infrared		2	Developed by NOTS GAR-8 is USAF version.
				Philco	Infrared			Advanced Sidewinder under development at NOTS greater speed and range formerly called Diamondback.
-General	1	spr		Sperry	Beam rider	2+	5+	Being replaced by Sparrow III
-General	1	spr		Raytheon	Semi-active radar homing	2+		All weather all aspect capability carried on 4's.
		spr						Test vehicle for ALBM.
l	1	lpr		Martin	Command	1 8	3	Some early Bullpups still using spr engines GAM-83B in R&D. White Lance is USAF version
l	—	lpr		Texas Instr /W L Maxson		1+		Stand-off missile for carrier aircraft prepackaged lpr engine Patriot.
					Homes on enemy radar			
					Unguided			
	1	J52 tj	7 500	Autonetics	Inertial		500+	For B-52G
	1	J85 tj	2 500	—		0 9	200	Also Green Quail diversionary missile for B-47, B-52
rcraft	3	lpr	12 000	Bell Aircraft	Radar-command	1 5	150	For B-47
-General	—	spr		Nortronics			1,000	Air launched ballistic missile. GE nose cone.
				Minn.-Honeywell	Inertial			
	1	spr			Unguided	3		Five inch folding fin rocket developed by NOTS to replace WW II HVAR also air-to-air
								Fired from gun launchers on destroyer escorts and frigates variable range
		spr						Developed by NOTS
l		spr		Kearfott/Librascope				Fired through torpedo tubes developed by Naval Ordnance Laboratory
ardt	2	RJ43-MA-3rj	10 000	Westinghouse	SAGE/active radar homing	2+	400	Spr booster replaces shorter range IM-99A with lpr booster
-General	1	XM22E5 spr		Raytheon	Semi-active radar homing		60	Low altitude complement to Nike mobile or fixed site launchers Effective at minimum altitudes
								Truck transportable tactical weapon for use against low flying aircraft.
-General	1	lpr	2 800	Western Electric	Command		25	One spr booster
l	1	spr		Western Electric	Command		75+	Four 14 5-ft Ajax spr boosters.
strad/Thiokol		spr		Bell Tel./Sanders Assoc	Command			Anti-missile missile.
				Philco/Convair	Infrared			Shoulder-fired weapon for low flying aircraft.
nell	1	rj	—	Sperry	Beam rider/semi-active hom'g	2+	65+	Also surface-to-surface uses spr booster
d	1	spr		Raytheon		1+	15	Smaller version of original Terrier designed for destroyer use dual thrust motor
c Research	1	spr		Sperry	Beam rider	2 0	10	Advanced Terrier now in production improved guidance 20-mi range spr booster
								Tactical nuclear weapon man transportable
tdyne	3	lpr	300 000	GE/Burroughs/Arma	Radar-command inertial	60	5 500+	Two 150,000-lb thrust lpr boosters one 60,000-lb sustainer GE MK III nose cone.
		RJ					5,500	Possible chemical forerunner to nuclear Slam
ardt	1	Nuclear rj	—		Command/inertial	1+	5 500+	Supersonic low alt NAA & Convair have study contracts.
	2	spr	17 5		Command	0 8	1 5	Wire-guided anti tank missile, made under license from Boelkow KG West Germany
	1	lpr	60 000	Gilfillan	Command	3	75	Nuclear and all-weather capability deployed in Europe.
las	1	spr			Unguided	—	15	Highly mobile tactical weapon deployed in Europe, Japan GE arming & fuzing.
las	1	XM31E?			Unguided			Improved Honest John with greater range accuracy
tdyne	1	lpr	150,000	Ford Instrument	Inertial	12	1 500	IRBM developed by Army used by Air Force.
al	1	M 10E1 spr		Martin	Command		20	Close tactical support GE arming & fuzing.
las	1	XM27E1 spr			Unguided			Close tactical support GE arming & fuzing.
	1	spr				2	15	Supply missile project 50 lb payload.
	1	J33-A-41 tj	5 200	Goodyear/AC	ATRAN/Inertial	0 9	650+	Improved Matador; high-low altitude capability spr booster
	1	J33-A-37 tj	5 700	GFE/Martin	MSQ radar/Shanicle	0 9		Tactical weapon deployed in Europe, Taiwan Korea spr booster
l Aerojet, Hercules	3	spr		NAA Autonetics	Inertial	20	5 500+	Will be launched from railroad cars/underground silos Avco nosecone.
ol	2	spr		Bendix	Inertial	—	450	Selective range ballistic missile.
-General	2	spr		GE	Inertial		1 200	Launched from subs using Ship's Inertial Navigation System developed by Sperry 2 000-mi model planned
tdyne	1	lpr	78 000	Ford Instr	Inertial		200	Deployed in Europe 1st stage Mercury capsule.
	1	J33-A-18A tj	4 600	Sperry	Command	0 9	600	Production ended nuclear capability spr booster
	1	J79-GE-3 tj	15 000+	AC	Command or inertial	2+	1 000+	Improved Regulus I limited production
ol	1	spr		Sperry	Inertial		200	Air transportable, will replace Corporal.
								Close-in support of troops.
	1	J-57	15 000	Nortronics	Stellar inertial	0 9	5 500	Two spr boosters first.
dyne	1	lpr	150 000	AC	Inertial		1 500	First units in England GE nose cone.
-General	3	lpr	380 000	AC/STL/Rem. Rand/IBM	Radar-command inertial	20	5 500	Avco nose cone range may reach 9 000 mi.

...tral Hercules Co.
...ental ballistic missile
...ate range ballistic missile
...sion Laboratory

lpr — liquid propellant rocket
MIT — Mass. Institute of Technology
NOTS — Naval Ordnance Test Station

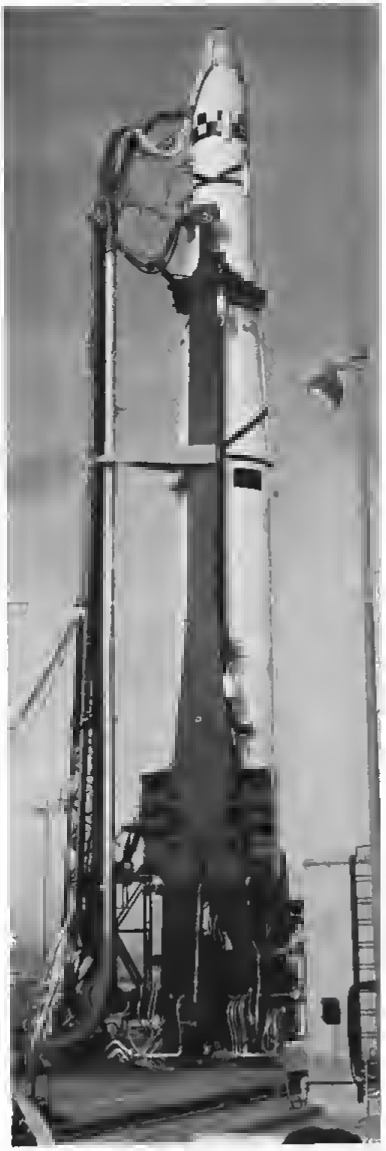
RMD — Reaction Motors Div of Thiokol Chemical Corp
spr — solid propellant rocket
tj — turbojet

tp — turboprop
WeEl — Western Electric
[1] Gross takeoff weight

U. S.—U.S.S.R: Satellites and Space Probes

Name	Origin	Launch Date	Lifetime or End	Dimensions (in.) length x diam.	Weight lb.	Initial Altitude (miles) Perigee	Apogee	Period (min.)	Inclination to Equator (degrees)	
Sputnik I	U.S.S.R.	Oct. 4 '57	Jan 4 '58	22 8	184	142	588	96 2	64 3	
Sputnik II	U.S.S.R.	Nov 3, '57	Apr 13 '58		1,120	140	1,038	103 7	65 4	
Explorer I	U.S.	Jan 31 '58	3-5 years	80 x 6	30 8	224	1 573	114 8	33 3	Jup
Vanguard I	U.S.	Mar 17 '58	2 000 years	6 4	3 25	409	2 453	133 8	34 3	Van
Explorer III	U.S.	Mar 26, '58	June 27 '58	80 x 6	31 0	121	1 740	115 9	33 4	Jup
Sputnik III	U.S.S.R.	May 15, '58	Est. Mar 1960	141 x 68 (at base)	7 000 (payload 2 925)	135	1 167	106	65 3	
Explorer IV	U.S.	July 26, '58	1 year	80 4 x 6 3	38 4	163 0	1 380	110 2	50 3	Jup
Pioneer I	U.S.	Oct. 11 '58	43 hr 17 5 min.	29 x 29	84 4					Th
Pioneer III	U.S.	Dec 6 '58	38 hr 6 min	23 x 10	12 95		63 580			Jun
Project Score	U.S.	Dec 18, '58	Jan 21 '59	1020 x 120	8 750 (payload 150)	114 0	926	100	32 3	Atl
Mechta	U.S.S.R.	Jan 2 '59			3 245 (payload 796 07)	91 million (perihelion)	122 8 million (aphelion)	450 days		
Vanguard II	U.S.	Feb 17 '59	200 years	20	23 7	347	2 046	125 9	32 9	Van
Pioneer IV	U.S.	Mar 3, '59		20 x 9	13 4	91 7 million (perihelion)	106 1 million (aphelion)			Jun
Discoverer I	U.S.	Feb. 28, '59	Mar 5, '59	19 2 x 5	1 300	99	605	95 9	3 deg off N-S axis	Th
Discoverer II	U.S.	Apr 13 '59	Apr 26, '59	230 4 x 60 with 27 x 33 capsule	168 (capsule)	142	220	90 5	Polar	Th
Explorer VI	U.S.	Aug 7 '59	1 year	20 x 26 (four solar paddles 18 x 18)	142	156	26 357	12 5 hr.	45 0	Th
Discoverer V	U.S.	Aug 13 '59		Same as Discoverer II	1 700 incl. 300 lb capsule	136	450	94	Polar	Th
Discoverer VI	U.S.	Aug 19, '59		Same as Discoverer II	1 700 incl. 300 lb capsule	139	537	95 3		Th
Lunar Probe	U.S.S.R.	Sept. 12 '59	Impact on moon Sept. 13 '59		858 4			Flight time about 35 hr		
Vanguard III	U.S.	Sept. 18, '59	30-40 years	20 in sphere with 26-in tapered tube	100 (payload 50)	319	2 329	130 2	33 3	Va
Lunar Probe	U.S.S.R.	Oct. 4, '59		—	614	24,500 (initial)	292 000	15 day (initial)		
Explorer VII	U.S.	Oct. 13 '59	20 years	30 x 30	91 5	342	680	101 3	50 3	Jun
Discoverer VII	U.S.	Nov 7 '59		Same as Discoverer V	1 700 incl 300 lb capsule	104	600	95	Polar	Th
Discoverer VIII	U.S.	Nov 20, '59		Same as Discoverer II	1 700 incl. 300 lb. capsule	129	1 000		Polar	Th
Transit	U.S.			36	268					Th
Midas	U.S.									Th At
Samos	U.S.									Th At
Courier	U.S.									
Decree	U.S.									
Steer	U.S.									
Mercury	U.S.				2 400	110 (est.)	150 (est.)			Al
Tiros	U.S.									Th
Echo	U.S.			100 ft. inflatable sphere		900 mi. circular orbit (est.)			Est. 50	De
Thor-Able IV	U.S.			26 in. plus four solar paddles	80					Th
Nimbus	U.S.		6 mos		500	600 N M (circular)			Polar	Th
Nerv	U.S.						2-10 000 (est)			Ar

Launching Vehicle				Remarks
Designation	Stages	Thrust (lb.)	Weight (lb.)	
				First artificial satellite recorded internal temperatures and pressures
				Led to discovery of significant solar influence on upper atmosphere densities
ter-C	4	84,000	84,000	Discovered Van Allen radiation belt.
guard	3	36,000	22,000	Tested solar batteries revealed pear-shaped Earth
ter-C	4	84,000	84,000	Recorded cosmic ray intensity and incidence, micrometeorite data.
				Analyzed cosmic radiation; measured tension of Earth's electrostatic field and magnetic field, atmospheric composition
ter-C	4	84,000	84,000	Measured corpuscular radiation
or-Able I	3	160,000	111,000	First determination of density of micrometeors in space; first measurements of interplanetary magnetic field
n II	4	151,000	121,000	Discovered 2nd radiation belt around Earth
as 10-B	1½	360,000	244,000	First time human voice beamed from outer space. Accepted and relayed messages from ground stations
				First to reach vicinity of the moon; first man-made asteroid
iguard	3	36,000	22,000	Cloud cover satellite
n II	4	151,000	121,000	Earth-Moon trajectory; yielded excellent radiation data.
or Agena	2	165,000	108,450	
or-Agena	2	150,000	108,400	Total payload weight is 440 lb.
or-Able III	3	160,000	105,000	Solar energy primary power source; used Telebit digital telemetry system to store, tally and transmit data.
or Agena	2	150,000	105,000	Payload capsule ejected but not recovered
or Agena	2	165,000	105,000	
				Traveled 236,873 miles. Impact velocity more than 2 mi./sec
oguard	3	36,000	22,000	Measuring earth's magnetic field, intensity of solar x-rays, and frequency of micrometeorite impacts.
				Took first picture of far side of the moon
n II	4	151,000	121,000	Studied direct solar radiation.
or-Agena	2	165,000	108,400	Launched from Pacific Missile Range into polar orbit.
or-Agena	2	150,000	108,400	Capsule ejected 26 hrs. after launch; missed target area; was not found.
or-Able	2	160,000	100,400	NAVY/ARPA developmental navigation satellite
or-Agena B and as-Agena B	2			USAF infrared early warning satellite
or-Agena B and as-Agena B	2			USAF reconnaissance satellite
				ARPA developmental teletype repeater communication satellite
				ARPA developmental 24-hr. orbit communications satellite
				ARPA developmental polar communications satellite. GE vehicle Bendix communications equip.
ius D	1½	360,000	244,000	Manned orbital capsule planned for launch by NASA in 1961–
or-Able	2	160,000	100,000	NASA meteorological satellite with two television cameras
Thor	3	150,000	100,000	NASA passive communications satellite launch vehicle is modified Thor-Able.
or-Able	3	160,000	100,000	NASA solar satellite to travel between orbits of venus, earth and test radio communications at 50 million mi. or more
or-Agena B	2	160,000	113,000	Earth-oriented meteorological satellite using advanced televisions, scanning and non-scanning infrared spectrometer and radar on later versions.
ge D4	4			Deep space probe to measure earth radiation belt; GE developing for NASA



Thor/Agena for launching Discoverer IX.

U.S. Research and Test Vehicles

CATEGORY	Vehicle name	GENERAL: User	GENERAL: Prime Contractor	AIRFRAME: Manufacturer	AIRFRAME: Overall length less booster, ft.
Satellite Vehicles	Atlas Able	USAF/NASA	STL	Convair	93 4"
	Atlas Centaur	NASA	Convair	Convair	107' 8"
	Atlas-Agena	USAF/NASA	Lockheed Aircraft	Convair/Lockheed	88 2"
	Juno II	NASA	NASA Huntsville	Chrysler	76 5
	Little Joe	NASA		North American	44 3
	Nuva	NASA			
	Saturn	NASA	NASA-Hunts.	NASA-Hunts.	
	Scout	NASA	Chance Vought	Chance Vought	
	Thor-Agena	USAF/NASA	Lockheed Aircraft	Douglas/Lockheed	79'
	Thor-Able	USAF/NASA	Space Technology	Douglas	88 1
Test Vehicles	Cherokee	USAF	Cook Electric		25
	Cree	USAF	Cook Electric		
	Fogo-Hi		U of New Mexico		
	Rickee 1	USAF	Cook Electric		30
	X-7	USAF	Lockheed Aircraft		
	X-17	USAF	Lockheed Aircraft		40
Research Vehicles	Aerobee	Army-Navy-USAF	Aerojet-General	Aerojet-General	19
	Aerobee 75	Army	Aerojet-General	Aerojet General	19
	Aerobee 150	Navy-USAF	Aerojet-General	Aerojet-General	21
	Aerobee 300	USAF	Aerojet-General	Aerojet-General	
	Argus	Navy	Atlantic Research	Atlantic Research	5 5
	Arcas Robin	USAF	Atlantic Research	Atlantic Research	6
	Arcon	NASA	Atlantic Research	Atlantic Research	11 1
	Asp 1	Navy	Cooper Development	Cooper Development	12
	Ascamp		Cooper Development	Cooper Development	18 3
	Aspan 150		Cooper Development	Cooper Development	26 4
	Cajun	USAF	U of Michigan		13 9
	Dan	Navy	Cooper Development	Cooper Development	27
	Deacon	NASA	ABL/Hercules	ABL	9 2
	Hasp	Navy	Cooper Development	Cooper Development	5
	HTV-1 HTV-2	USAF USAF	Curtiss-Wright Curtiss-Wright	Curtiss-Wright Curtiss-Wright	43
	Iris	NASA	Atlantic Research	Atlantic Research	19
	Jason	NASA			50
	Nike-Nike	USAF	Marquardt	Cooper Development	22 2
		AEC	Cooper Development	Cooper Development	20 4
	Rockair	Navy			4
	Rockaire	USAF	Douglas		8 9
	Rokasonde 200		Cooper Development	Cooper Development	8 7
	Wasp	Navy	Cooper Development	Cooper Development	

Body diameter, ft.	Launching wt, less booster, lb.	POWERPLANT: Manufacturer	No. of engines	Engine Designation	Rated thrust, lb.	REMARKS
12		N.A.A. Rocketdyne Aerojet-General Allegany Ballistic Lab. STL	3 1 1 1	lpr AJ-10 lpr ABL-248 spr spr	360 000 7 500 2 500	Also known as Able IV Atlas 4th stage retrorocket carrier for NASA lunar vehicle.
		Rocketdyne F&W	3	lpr	360 000	High energy general-purpose space vehicle Canvas 2nd stage
10		N A A Rocketdyne Bell Aircraft	3 1	lpr spr	360 300	Reconnaissance satellite will use Atlas I unch vehicle for Midas and Samos satellites NASA satellites and probes
8 8	121 000	N.A.A Rocketdyne JPL	1 16	lpr spr	150 000 1 000	Fourstage carrier for Pioneer III and for lunar probe and satellite Iral stage a modified Jupiter upper stages scaled down Sergeant rockets.
8 8		Thiokol	8	spr	330.000	Used in testing Mercury capsule
		N A A Rocketdyne N A A Rocketdyne	4 1	lpr lpr	3 000 000 1 500 000	Up to five stages depending upon mission stages 3 and 4 liquid hydrogen and oxygen Rs storable lpr engine 1st launch 1965.
		N.A.A. Rocketdyne	8	lpr	1 000 000	Super booster now in R&D phase Up to 8 stages all upper stages hydrogen and oxygen 1st launch 1962
		Aerojet-General Thiokol Hercules				Basic mission is to place 150-lb. payload in a 300-mi orbit
8		N A A Rocketdyne Bell Aircraft	1 1	lpr lpr	150. 000	Two-stage carrier for Discoverer satellite will use Thor 1st stage engine developed by Bell for B-58 pod as 2nd stage Agene B will have increased thrust, restart capability
8		N.A.A Rocketdyne Aerojet-General Allegany Ballistic Lab. Thiokol Chemical	1 1 1 1	lpr AJ-10 lpr spr ABL-248 spr	150 000 7 500 2 000	Also known as Able I carrier for Pioneer II lunar probe 2nd stage is Vanguard 2nd stage 4th stage is Pelcon motor used as a retrorocket. Thor-Delta has guidance in 2nd stage
4 2	4 500		1	spr	80 000	Test vehicle for ejection seat development an launched
						Supersonic vehicle will be used by WADD to test 14-18 in parachutes for missiles, drones and escape capsules.
						Infra-red high altitude target for heat-homing missiles
1 7	2 400		2	spr	33 000	Air launched parachute test vehicle Skokie II is Mach 2 version
			1	rj		Ramjet engine test pod
		Thiokol Chemical	3	spr		Three-stage re-entry test vehicle
1 3		Aerojet-General	1	lpr	4 000	Sounding rocket 150-lb payload to 70 mi
1 2		Aerojet-General	1	dual thrust spr		Sounding rocket 80-lb payload to 75 mi. (Aerobee Hewkl
1 3		Aerojet-General	1	lpr	4 100	Was Aerobee-Hi 150-lb payload to 150 mi
1 3		Aerojet-General	1 1	lpr spr	4 100	Sounding rocket 50-lb. payload to 300 mi.
0 4	77	Atlantic Research	1	spr	360	Sounding rocket 12-lb payload to 40 mi. altitude
0 3	73	Atlantic Research	1	spr	360	Sounding rocket 8-lb payload to 40 mi altitude.
0 3	254	Atlantic Research	1	spr	945	Sounding rocket 40-lb payload to 81 mi altitude
0 1	218 6	Cooper Development	1	spr	8 850	Sounding rocket 10-85-lb payload to 130.000-250,000 ft. altitude ApplV has 500 000-ft. altitude capability
5 54	286 5		2	spr		Will carry 16-70 lb payloads to 50-150 mi altitude Nike Ascamp uses Nike booster to carry 50-75 lb payload to 250-400 mi altitude.
1 4	1 503		2	spr		Will carry 20-80 lb payload to 125-200 mi. altitude Aspan 200 to 225-425 mi altitude.
0 3	254	Thiokol Chemical	1	spr	8 300	Nike-Cajun offered by Cooper Development uses Nike JATO M-5 as booster
0 3	1 482		1 1	Nike JATO M-5 Deacon spr		Two-stage sounding rocket 50-lb payload to 75 mi
0 1	183	ABL/Hercules	1	spr		Sounding rocket.
0 3		Cooper Development			3 300	Weather rocket 35-mi. altitude capability
0 8	320	Grand Central Grand Central/Thiokol	11 3	Arrow 1 Arrow 1. Recruit		Two stage spr hypersonic test vehicle. Three stage spr hypersonic test vehicle.
1	1 228	Atlantic Research	1	spr	4 810	Sounding rocket, 100-lb payload to 100 mi altitude
	7 000	Radford/Hercules	3	spr		Five-stage research vehicle consists of Honest John 2 Nike boosters Recruit and T-55 engine
1 2	3 540	Radford/Hercules Thiokol Chemical	1 1	Nike JATO M-5 spr		Two-stage sounding rocket 50-lb. payload to 105 mi Another version of Nike Cajun
0 9	408	JPL Cooper Development	1 1	3"-427 Asp I spr		Two-stage sounding rocket recoverable payload
0 2	18	Sunflower/Hercules	1	spr		2 75-in FFAR rocket instrumented for sounding experiments.
0 8	181		1	DM-38 JATO	7 600	Air-launched sounding rocket 40-ft payload
0 25	23		1	spr		Can carry small payloads above 200,000 ft.
		Cooper Development				Weather sounding vehicle

U. S. Gas Turbine Engines

Manufacturer and Address	Designation	Type	No. of compressor stages, axial, centrifugal	No. of turbine stages	No. of combustors	Max power at S. L.	Specific fuel consumption at max. power, lb./hr./lb. or eshp.	Compression ratio at max. rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, lb.	Remarks
Avco Manufacturing Corp. Lycoming Division *Stratford, Conn.*	T53-L-1	ACS	5,1	1		860 shp.	0.77	6	23	47.6	480	HU-1A, H-43B
	T53-L-3	ACP	5,1	1		960 shp.	0.687	6	23	58.9	530	AO-1
	T53-L-5	ACS	5,1	1		960 shp.	0.680	6	23	47.1	485	Will power HU-1B
	T55-L-1	ACP	7,1	1		1,860 shp.	0.470	6.3	24.25	58.3	655	
	T55-L-3	ACS	7,1	1		1,910	0.470	6.3	24.25	44	520	Will power YHC-1B
	T55-L-5	ACP	7,1	1		2,200	0.466	6.3	24.25	44	570	
Boeing Airplane Co. *Seattle, Wash.*	502-10CA	CS	1	2	2	270 shp.	0.97	4.1	24	41.5	320	
	502-10B	CS	1	2	2	240 shp.	0.98	4.47	24	41.5	335	Radioplane RP 77D
	502-11B	CFG	2	2	2	165 air hp.		3.6	25.5	58	350	Compressed air output.
	T50 (520-2)	CS	1	2	2	430 shp.	0.72	5.25	25.5	47.32	325	Helicopter type.
	502-10V	CS	1	2	2	270 shp.	1.02	4.40	24	41.5	290	Turboshaft.
	502-10E	CS	1	2	2	325 shp.	0.80	4.66	25	41.5	335	Turboprop.
	502-10WA	CS	1	2	2	235 shp.	0.96	4.35	24	41.5	300	Turboshaft.
	520-F	CS	1	2	2	475 shp.	0.74	5.52	25.5	68.67	395	Turboprop.
	550-7	CS	1	2	2	550 shp.	0.65	6	25.5	57.32	265	Turboshaft
	550-8	CS	1	2	2	550 shp.	0.65	6	25.5	68.67	275	Turboprop.
Continental Aviation & Eng'g. Corp. *Detroit, Mich.*	J69-T-25	CFJ	1	1	1	1,025 lb. t.	1.14		21.5	50	361	Cessna T-37B
	J69-T-29	ACJ	2	1	1	1,700 lb. t.	1.10			40.1	335	Ryan Q-2C
	T51-T-3	CFP	1	5	1	125 eshp.	0.97			38	236	
	Model 217-5A	ACP	2	2	1	400 bhp.	0.67		15.38	43.25	245	6,500 rpm.
	Model 217-6A	ACS	2	3	1	500 bhp.	0.67		15.38	48.63	245	2,100 rpm.
	Model 324	ACJ	2	2	1	550 lb. t.	0.97		10.1	65.5	211	
	Model 320	CFJ	1	1	1	360 lb. t.	1.22		10.5	28.5	158	
	Model 141	CFJ	1	1	1	151 air hp.					157	For pressure-jet helicopter
Curtiss-Wright Corp. Wright Aeronautical Division *Wood Ridge, N. J.*	J65-W-5	AFJ	13	2	1	7,200 lb. t.			37.5	109	2,750	
	J65-W-7	AFJ	13	2	1	7,800 lb. t.			37.5	115	2,785	
	J65-W-16-18A	AFJ	13	2	1	7,700 lb. t.			37.5	113	2,737	
	J65-W-18	AFJ	13	2	1	10,500 lb. t.			37.5	184	3,485	
			5	2	1		5.68	2.70	11	15	30	Turbo-Mite APU Gas Turbine. Direct Drive at 24,500 RPM
General Electric Co. Aircraft Gas Turbine Division *Evendale, Ohio.*	J47-25	AFJ	12	1	8	7,200 lb. t.	1.500	5.35	36.75	145	2,554	B-47E water alcohol injection
	J47-27	AFJ	12	1	8	5,970 lb. t.	1.060	5.35	36.75	146	2,557	F-86F non-afterburning.
	J47-33	AFJ	12	1	8	7,650 lb. t.	1.15	5.35	36.75	228	3,158	F-86D afterburner
	J73-3	AFJ	12	2	8	8,920 lb. t.	0.917	7.0	39.75	117.2	3,650	F-86H non-afterburning.
	J79-2	AFJ	17	3	10	15,000 lb. t.		12	38.31	208	3,200*	F4H-1, A3J
	J79-3A	AFJ	17	3	10	15,000 lb. t.		12	38.31	204	3,200*	F-104A, B, Regulus II
	J79-5	AFJ	17	3	10	15,000 lb. t.		12	38.31	208	3,200*	B-58
	J79-7	AFJ	17	3	10	15,000 lb. t.		12	38.31	204	3,200*	CF-104, F-104C, D, F, G, F11F-1F
	J79-8	AFJ	17	3	10	15,000 lb. t.		12	38.31	204	3,200*	F4H-1, A3J
	J93-3	AFJ										B-70
	X211 Nuclear											Convair WS-125A bomber
	TF35	BFJ	17	3	10	15,000 lb. t.		12	32¹ 53²	144	3,700	
	CJ-805-3	AFJ	17	3	10	11,200 lb. t.	.806	12	32	189**	2,800	Convair 880 jetliner
	CJ-805-3B	AFJ	17	3	10	11,650 lb. t.	.806	12	32	189**	2,800	Convair 880M jetliner
	CJ-805-23	BFJ	17	3	10	16,100 lb. t.	.541	12	32¹ 53²	114	3,700	Aft Fan. Convair 600 jetliner, Caravelle Mark VII
Small Aircraft Engine Dept. *Lynn, Mass.*	T58-GE-6	AFS	10	2+1	1	1,050 shp.	0.61	8.3:1	16	55	271	HU2K-1, HSS-2, YHC-1A, N1224 (VTOL), X-18 (VTOL)
	T58-GE-8	AFS	10	2+1	1	1,250 shp.	0.61	8.3:1	16	55	285	First step growth. Qualified 1960
	CT-58-100	AFS	10	2+1	1	1,050 shp.	0.64	8.3:1	16	55	280	Civil counterpart of T58-6 Vertol 107 Model II, S-61, S-62*
	J85-GE-5	AFJ	8	2	1	2,850 lb. t.	2.20	7.1°	17.7	46	325	McDonnell GAM-72
	T64-GE-2	AFS	14	2+2	1	2,650 shp.	0.500	12.6:1	20	68	425	
	T64-GE-4	AFP	14	2+2	1	2,870 eshp.	0.522	12.6:1	26	113	1,070	T64-GE-4. Reduction gearing above engine centerline, perl. same as -4.
	T64-GE-6	AFS	14	2+2	1	2,650 shp.	0.468	12.6:1	20	62	710	Direct drive configuration
	CF 700-1	AFF¹²	8	2	1	1,400 lb. t.	0.65	7.1°	33	73	553	McDonnell 220C. J85 gas generator plus scaled-down version of CJ-805-23 Aft-Fan
Garrett Corp. AiResearch Mfg. Co. *Phoenix, Ariz.*	GTP70-30	RCS	2	1	1	100 shp.	1.04	3.50	28.0	31.0	175	Helicopter type weight includes starter motor & accessories
	GTC85-165	RCC	2	1	1	210 shp.	1.15	3.72	34.2	38.0	230	McDonnell 120 helicopter weight includes starter motor & access.
	GTP225B	RCS	2	1	1	305 shp.	1.10	1.30	20.5	41.0	265	Helicopter type weight includes starter, motor & access.
General Motors Corp. Allison Division *Indianapolis, Ind.*	J33-A-41	CFJ	1	1	14	5,100 lb. t.	1.11	1.30	52	156	1,820	
	J71-A-2	AFJ	16	3		10,000 lb. t.			13	285	4,017	
	T56-A-1	AFP	11	4	6	3,750 eshp.	0.51	5.25	10	145	1,845	
	T56-A-7	AFP	11	4	6	1,050 eshp.						
	T56-A-8	AFP	11	4	6	1,090 eshp.						
	T56-A-9	AFP	14	4	6	3,750 eshp.						
	T56-A-10W	AFP	14	4	6	4,585 eshp.						Water alcohol injection
	501-D13	AFP	14	4	6	3,750 eshp.	0.51	5.25	36	145	1,845	Lockheed Electra
	T63 turboprop	ACP	7,1		1	250 eshp.	0.70		10.5	38.5	116	Single-stage gas producer, two-stage power turbine
	T63 turboshaft	ACP	7,1		1	250 hp.	0.70		10.5	24.0	85	Max. width 15.8 in.
Solar Aircraft Co. *San Diego, Calif.*	T62	CS	1	1	1	80 shp.	1.10	3.42	15.0	24.7	30	Single shaft, constant-speed. T62 is variable speed.

Abbreviations:
- *—Approximate
- ACJ—Axial-centrifugal turbojet
- ACS—Axial-centrifugal shaft turbine
- AFP—Axial-flow turboprop
- CFJ—Centrifugal-flow turbojet
- CS—Centrifugal shaft turbine
- AFF—Axial-flow fan
- Eshp.—Equivalent shaft horsepower
- Lb. t.—Pounds thrust
- Shp.—Shaft horsepower
- ¹—Basic engine
- ²—Aft Fan

Manufacturer and Address	Designation	Type	No. of compressor stages, axial, centrifugal	No. of turbine stages	No. of combustors	Max power at S. L.	Specific fuel consumption at max. power, lb./hr./lb. or eshp.	Compression ratio at max. rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, lb.	Remarks
United Aircraft Corp. Pratt & Whitney Aircraft Division *E. Hartford, Conn.*	PT2G-7	AFP	15	3	8	7,500 eshp.	.55	6.7	34.06	165	2,870	
	JT3D-12	AFJ	15	3	8	13,500 lb. t.	.82	13	38.88		3,495	
	JT3D-3	AFF	15	3	8	18,000 lb. t.	.535	13	53		4,130	
	JT3D-5	AFF	15	3	8	20,000 lb. t.	.505	12	53		4,120	
	JT4A-11, -12	AFJ	15	3	8	17,500 lb. t.	.84	12	43		5,100	12 weight 4,995.
	JT12A-6	AFJ	9	2	8	3,000 lb. t.	.95	6.5	21.5	70	430	
	JT12A-8	AFJ	9	2	8	3,300 lb. t.	.995	6.5			465	
	JT12A-10	AFJ	9	2	8	3,000 lb. t.	.97	6.5	21.0	70	452	
	J57-P-20	J	16	3	8	18,000 lb. t.	2.35	13	38.9	253	4,750	JT3C-26
	TF33-P-3	AFF	15	3	8	17,000 lb. t.	.52	13	53		3,900	JT3D-2
	TF33-P	AFF	15	3	8	18,000 lb. t.	.535	13	53		3,750	JT3D-4
	J60-P-3	AFJ	9	2	8	3,000 lb. t.	.96	6.5	21.0	70	430	JT12A-5
	J60-P	AFJ	9	2	8	3,000 lb. t.	.995	6.6	21.0	70	440	JT12A-7
	T34-P-9W	AFP	13	3	8	7,500 eshp.	0.55	6.7	34.06	165.12	2,870	PT2G-6
	JT3C-6	AFJ	16	3	8	13,500 lb. t.	0.775	13	38.88		4,231	Civil J57
	JT3C-7	AFJ	16	3	8	12,000 lb. t.	0.785	13	38.88		3,465	Civil J57
	JT5D-1	AFF	15	3	8	17,000 lb. t.	0.52	13	53		4,025	Civil TF-33 turbofan
	J57-P-43W	AFJ	16	3	8	13,750 lb. t.	0.95	13	38.9	167.33	3,[illegible]	JT3C-2
	J57-P-16, -55	AFJ	16	3	8	16,000 lb. t.	2.30	12	38.5	250.34	4,780	JT3C-21
	JT4A-9, -10	AFJ	15	3	8	16,800	0.81	12	43	144.1	5,050	10 weight 4,845 lb. civil J75
	J75-P-17	AFJ	15	3	8	24,500	2.15	12	43	237.8	5,875	Afterburning JT4A-28
	J75-P-19W	AFJ	15	3	8	26,500	2.20	12	43	259.3	5,955	Afterburner, water injection JT4A-29
	J60-P	AFJ	9	2	8	2,900 lb. t.	0.96	6.6	21.0	75	430	JT12A-1
	J60-P	AFJ	9	2	8	3,900 lb. t.	2.20	6.6	21.0	126	661	JT12A-20.
	J58	AFJ				30,000+ lb. t.						JT11
	J42					5,500 lb. t.						JT8
Westinghouse Electric Corp. Aviation Gas Turbine Div. *Kansas City, Mo.*	J34-WE-34	AFJ	11	2	1	3,250 lb. t.	1.06	3.85	27	122	1,104	
	J34-WE-36	AFJ	11	2	1	3,400 lb. t.	1.04	4.3	27	111.5	1,184	
	J34-WE-46	AFJ	11	2	1	3,400 lb. t.	1.348	4.5	27	111.5	1,210	In T2J-1
	J34-WE-48	AFJ	11	1	1	3,400 lb. t.	1.049	4.43	27	111.5	1,175	In T2J

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- Eshp.—Equivalent shaft horsepower
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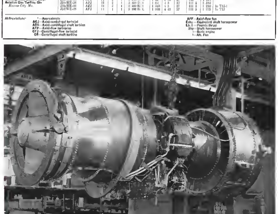

PRATT & WHITNEY JT3D TURBOFAN

Leading Foreign Gas Turbines

Manufacturer and Address	Designation	Type	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at max. power	Compression ratio at max. rpm	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
CANADA												
Orenda Engines, Ltd *Malton Ont*	Orenda 10	AFJ	10	1	6	6 355 lb. t.	1 12	5 3	42	123	2 515	
	Orenda 11	AFJ	10	2	6	7 275 lb. t.	0 88	6 1	45	121	2 425	
	Orenda 14	AFJ	10	2	6	7 275 lb. t.	0 99	6 1	45	121	2 425	
	Iroquois PS-13	AFJ	10	3	An	20 000+lb. t.		8	47	208	4 350	
GREAT BRITAIN												
Blackburn & General Aircraft, Ltd *Brough E Yorkshire*	Palouste 500	CFJ	1C	2	A	2 0 lb. air/sec	1 40	5 77	17 0	33 4	210	Spec fic fuel consumption based upon air horse power
	Palouste 505	CFJ	1C	2	A	2 7 lb. air/sec	1 20	3 81	17 5	33 4	615 5	
	Artouste 010	CFJ	1C	2	A	2 1.8 lb. air/sec.+ 100 shp.	350 lb./hr *	3 51	17 5	37 0	235	*Actual fuel consumption
	Artouste 510	CFJ	1C	2	A	2 6 lb. air sec	320 lb./hr *	3 83	17 5	47 0	235	*Actual fuel consumption
	Artouste 600	CFJ	1C	2	A	176 shp.	0 98	4 0	17 3	51 0	295	Length includes rotor
	Palas 600	CFJ	1C	1	A	390 lb. t.	1 2	4 50	17 5	43 0	170	
	A 129	ACFJ	2A, 1C	2×1	A	970 shp.	0 98	6 5	28 87	91 38	319	P 531 helicopter
	Turmo 303	CFJ	1C	1×1	A	425 shp	1 105	3 80	20 4	47 0	379	
Bristol Siddeley Engines, Ltd *Filton, England*	Double Mamba 3	AFP	10	3	A	3 145 eshp.	0 72	5 80	50	99	2,180	Gannet.
	Double Mamba 8	AFP	11	3	A	3 850 eshp.	0 90	5 85	50	100	3 410	Gannet.
	Viper 8	AFJ	7	1	A	1 750 lb.	1 07	4 1	24 3	62	510	Provost Mk. 5.
	Viper 9	AFJ	7	1	A	1 600 lb.	1 13	4 25	24 5	62	610	Uprated ASV 8. 326 prototype
	Viper 11	AFJ	7	1	A	2,480 lb.	1 04	4 37	24 5	64	646	MB 326 Macchi.
	Viper 12	AFJ	7	1	A	2 700 lb.	1 08	4 17	24 5	64	646	Uprated ASV 11
	Sapphire 6	AFJ	13	2	A	8 200 lb.	0 87	7 28	37 4	118	2 070	Javelin
	Sapphire 7	AFJ	13	2	A	11,000 lb.	0 88	7 40	37 5	128	3 110	Javelin, Victor
	Sapphire 7R	AFJ	13	2	A	12 250 lb.	1 38	7 40	37 4	138	3 119	Limited afterburner—Javelin
	Proteus 705	ACFP	12A 1C	2, 2	8	3 900 eshp.	0 82	7 2	40	150 0	3 005	Britannia 102
	Proteus 755	ACFP	12A 1C	2 2	8	4 160 eshp.	0 80	7 2	40	100 0	2,900	Britannia 300
	Proteus 765	ACFP	12A 1C	2 2	8	4 445 eshp.	0 60	7 2	40	100 0	2 900	Britannia 250 310 320
	Olympus 101	AFJ	6 8	1 1	10C	11 000 lb.	810		40	147 7	3 570	Vulcan B Mk 1
	Olympus 102	AFJ	7 8	1 1	10C	11 000 lb.	850		42 4	140 75	3,800	Vulcan B Mk 1
	Olympus 104	AFJ	7 8	1 1	10C	13 000 lb.			42 4	140 70		Vulcan B Mk. 1
	Olympus 200	AFJ	5 7	1 1	8C	16 000 lb.			41 0	130 3		
	Olympus 201	AFJ	5 7	1 1	8C	17 000 lb.			41 0	120 3		Vulcan B Mk. 2
	Orpheus 701	AFJ	7	1	A	4 700 lb.	1 067	4 30	32 4	83 25	700	Folland Gnat.
	Orpheus 803	AFJ	7	1	A	5 000 lb.	1 08	4 30	32 4	90 1	830	G 91 Etendard VI Taon Fuji Trainer
	Orpheus 100	AFJ	7	1	A	1 250 lb.	984	4 30	32 4	80 0	885	Gnat trainer G 91
	Orpheus 12	AFJ	8	2	A	6 810 lb.	867	5 7	32 4	85 0	1,110	
	Orpheus 12 SR	AFJ	8	2	A	8 170 lb.	1 62	0 7	32 4	60 0	1,110	Afterburner, basic thrust 6810
De Havilland Engine Co., Ltd. *Leavesden Hertfordshire*	Goblin 35	CFJ	1	1	10	3 500 lb. t.	1 10	4 7	50	110	1,620	DH Vampire Trainer
	Ghost 103	CFJ	1	1	10	4 850 lb. t.	1 10	4 3	53	160	2,457	DH Venom F B Mk 4.
	Ghost 105	CFJ	1	1	10	5 300 lb. t.	1 10	4 7	53	136	2 135	DH Sea Venom N F Mk. 22.
	Gyron D Gy 2	AFJ	7	3	A	20 000 lb. t.	1 04		50	150	4 270	
	Gyron Jr D G.J 1	AFJ				7 000 lb. t.			41	64		
	Gyron Jr D G J 10	AFJ				10 000 lb. t.			40			Research aircraft.
	Gnome H. 1000	AFS	10	2 1	1	1 000 shp.	0 67	8 3	20	61	298	GET58-6 equiv Westland whirlwind & various copters.
	Gnome P 1000	AFP	10	2 1	1	1 000 shp.	0 60	8 A	22	76	600	British design-turboprop version of T58-6
	Gnome H. 1200	AFS	10	2 1	A. 1	1 250	82	8 3	20	61	320	GET58-8 equiv. various copters.
	Gnome P 1200	AFP	10	2, 1	A. 1	1 150	80	8 3	22	76	600	Turboprop version of H 1 200.
D Napier & Son, Ltd. *London*	Eland N El 1	AFP	10	3	6	3 000 eshp	0 64	7	30	122	1 570	
	Eland N El 3	AFP/G	10 9	3	6	3 700 eshp	0 62	7	30	155	2 435	
	Eland 504	AFP	10	3	6	A 500 eshp	0 61	7	31	118	1,820	Convair 540/440.
	Eland N El 7	AFP/G	10 9	3	6	3 694 eshp	0 60	7	30	158	2 570	Uprated N El 3.
	Eland E 211	AFP	10	3	6	3,710 eshp	0 60	7	30	125	1 413	Uprated E 229A.
	Oryx N Or 1	AFG	12 4	2	8	750 ghp	0 58	6	16	63	438	
	Oryx N Or 4	AFG	12 4	2	8	865 ghp.	0 56	5	16	63	468	
	Oryx N Or 6	AFG	12 4	2	8	935 ghp.	0 60	6 1	10	63	510	
	Gazelle N Ga. 1	AFP	11	2+1	6	1 260 shp.	0 71	6 37	64	70	780	
	Gazelle N Ga. 2	AFP	11	2+1	6	1 650 shp.	0 68	6 37	24	70	850	Bristol 192
	Gazelle N Ga. 3	AFP	11	2+1	6	1 600 shp.	0 50	6 37	24	70	865	
	Gazelle N Ga. 4	AFP	11	2+1	6	2 100 shp.	0 635	6 37	34	70	900	
	Eland E 229A	AFP	10	3	6	3 440 eshp	0 62	7	30	148	1 418	Twin unit for Westminster
	Eland 606	AFP	10	3	6	1 430 shp.	0 61	7	26	118	1 520	Uprated 504
	Gazelle N Ga 18	AFP	11	2+1	6		0 60	5 9 1	61	70	865	Wessex
Rolls-Royce, Ltd. *Derby*	Avon RA 7	AFJ	12	2	8	7 400 lb. t.	0 92	6 5	42	112	2 480	
	Avon RA 7R	AFJ	12	2	8	9 000 lb t.	1 50	5 0	42	120	2,395	Afterburner
	Avon RA 21	AFJ	12	2	8	8 000 lb t	0 85	6 0	42	117	2 473	
	Avon RA 14	AFJ	10	2	A	9 000 lb t	0 84	7 5	42	113	2 397	
	Avon RA 26	AFJ	10	2	A	10 500 lb t.	0 85		42	113	2,750	
	Avon RA 28	AFJ	10	2	A	10 000 lb t.	0 85		42	113	2 800	Modified RA. 28 in Ryan X-13
	Avon RA 24	AFJ	10	2	A	11 250 lb t.						
	Avon RA 24R	AFJ	10	3	A							Afterburner
	Avon RA 29	AFJ	10	3	A	10 500 lb t.	0 770		42	120	3 325	D H Comet, Sud Caravelle
	Conway RCo 11	BPJ			A	17 250 lb t.			42	130		
	Conway RCo 12	BPJ	7+9	1+2	10	17 500 lb t.	0 725	14 1	42	131	4 500	Boeing 707-420 DC-8.
	Conway RCo 10	BPJ	7+9	1+2	10	18 500 lb t.	0 701	14 1	48	131	4 544	DC-8
	Conway RCo 42	BPJ		1+2	10	20 250 lb t	0 630				5 001	Vickers VC-10.
	R.B 141	BPJ			10	13 000 lb t.			39 4	114 0		Caravelle 7
	R.B 140	BPJ				2 750 lb t.						
	R.B 108	AFJ			A	2 010 lb t.						VTOL engine Short S.C. 1
	R.B 163	BPJ				10 100 lb t						DH 121
	Dart Mk 506	CFP	2	2	7	1 540 eshp	0 727	5 6	39	88	1,000	Viscount 700 & 800.
	Dart Mk 510	CFP	2	2	7	1 740 eshp	0 620	6 0	39	98	1 110	
	Dart Mk 511	CFP	2	2	7	1 720 eshp	0 603	6 0	38	98	1 155	Fokker/Fairchild F 27
	Dart Mk 520	CFP	2	3	7	1 670 eshp.	0 7	6 0	38	98	1,250	Viscount 806.
	Dart Mk 525	CFP	2	3	7	1 600 eshp	0 60	5 8	38	99	1 250	Viscount 810.

Abbreviations.
A — Annular
ACFJ — axial-centrifugal turbojet
ACFP — axial-centrifugal turboprop
AFG — axial-flow gas generator
AFJ — axial-flow turbojet
AFP — axial-flow turboprop
BPJ — bypass turbojet
CFJ — centrifugal-flow turbjet
CFP — centrifugal flow turboprop
eshp — equivalent shaft horsepower
ghp — gas horsepower
lb. t. — pounds thrust
¹ — Lb./hr /lb. thrust
² — Lb./hp /hr.
³ — Lb. /hr

Manufacturer and Address	Designation	Type	No. of compressor stages	No. of turbine stages	No. of combustors	Max. power @ S. L.	Specific fuel consumption at max. power	Compression ratio at max. rpm	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	Remarks
Rolls-Royce, Ltd. (Cont'd) *Derby*	Dart Mk 526	CFP	2	3	7	3 150 eshp.	0 600	5 8	38	98	1 250	A.W 650 Freightcoach.
	Dart Mk 527	CFP	2	3	7	3 100 eshp.	0 600	5 6	38	98	1 250	H P Dart Herald.
	Dart Mk 529	CFP	2	3	7	1 650 eshp	0 600	5 6	38	98	1 276	Fairchild F 27
	Dart Mk 530	CFJ	2	3	7	2 105 eshp	0 600	5 8	37 0	96 0	1 260	Viscount 805.
	Dart Mk 529	CFP	2	3	7	2 150 eshp	0 600	6 8	38	98	1 250	Grumman Gulfstream.
	Dart Mk 21	CFP	2	3	7	2 150 eshp.	0 610	6 8	38	98	1,240	1050 Alize
	Dart RDa. 10	CFP	3	3	7	2 800 eshp.	0 64	6 25	39	98	1 323	
	Dart Mk 541	CFP	2	3	7	2 350 eshp	0 670	6 25	38	98	1 322	Viscount 840.
	Tyne RTy 1	AFP	6+9	1+3	A	4 985 eshp.	0 499	13 1	41	110	2 220	Vanguard.
	Tyne RTy 11	AFP	6+9	1+3	A	5 525 eshp	0 48	13 1	41	110	2 124	Vanguard.
	Tyne RTy 12	AFP	6+9	1+3	A	5 730 eshp.	0 440	13 1	41	110	2 220	Canadair CL-44.
	Avon RA 29/3	AFJ	16	3	8	11 700	0 806		42	115 5	3 287	Caravelle 3.
	Avon RA 29/6	AFJ	17	3	8	12 600	0 762		42		3 491	Caravelle 6.
	Avon RB146	AFJ			8	15 220						Military Engine.
FRANCE												
SNECMA, *Paris*	Atar E3	AFJ	8	1	A	7 710 lb. t.	1 58	4 8	36	162	1 851	
	Atar E4	AFJ	8	1	A	8 150 lb. t.	1 00	4 9	36	162	1 851	
	Atar E5	AFJ	8	1	A	8 150 lb. t.	1 06	4.8	36	162	1,881	
	Atar G2 G3	AFJ	8	1	A	9 700 lb. t.	1 60	4 8	40	553	2 720	
	Atar C8	AFJ	9	2	A	9 700 lb. t.	0 98	6 2	40	181	2 180	
	Atar C9	AFJ	9	2	A	13 280 lb. t.	2 07	5 3	42	264	2,350	
	Atar 9C	AFJ	9	2	A	14 100 lb. t.	2 07	5 3	42	800	2 750	
Generale Aeronautique Marcel Dassault *St. Cloud*	M D 30 Viper	AFJ	7	1	A	1,830 lb. t.	1 10	3 9	27	60	498	Bristol-Siddeley license
	M D 30R	AFJ	7	1	A	2 205 lb. t.	2 80	3 8	27	132	701	M D 30 with afterburner
	R. 7	AFJ	7	1	A	3 000 lb. t.	1 07	0 3	30	79	748	
Societe Turbomeca *Paris*	Palas	CFJ	1	1	A	352 lb. t.	1 17¹	3 56	16	47	166	
	Marbore II	CFJ	1	1	A	600 lb. t.	1 10¹	3 86	66	62	314	
	Marbore VI	CFJ	1	1	A	1 056 lb. t.	1 05¹	3 84	22	56	322	
	Gourdon	ACFJ	1	1	A	1 410 lb. t.	89¹	5 00	22	69	370	
	Gabizo	ACFJ	1	1	A	2 430 lb. t.	1 53¹	0 70	26	82	555	
	Artouste II	CFP	1	2	A	450 shp.	1 07²	3 84	23	67	350	
	Artouste III	ACFP	1	3	A	600 shp.	65²	0 20	21	68	410	
	Astazou		2	3	A	420 shp.	65²	5 81	18	65	297	
	Turmo III B	CFP	2	3	A	812 shp.	67²	5 58	31	55	600	
	Turmo III C	CFP	2	3	A	1 100 shp.	68²	5 00				
	Palouste IV		1	2	A		2 60³	3 90	22	47	200	
	Astazou	ACFP	2	3	A	50 lb. t./450 shp.	62²	0 01	18	67	320	
	Bastan	ACFP	2	3	A	14 5 lb. t./900 shp.	65²	6 45	62	61	607	
	Palouste VI		1	2	A		0 97³	3 7	22	47		
ITALY												
FIAT-SMA *Turin*	4002.001	CFJ	1	1	A	560 lb. t.	1 28	4	62	41	220	

Abbreviations:
A — Annular
ACFJ — axial-centrifugal turbojet
ACFP — axial-centrifugal turboprop
AFG — axial-flow gas generator
AFJ — axial-flow turbojet
AFP — axial-flow turboprop
BPJ — by pass turbojet
CFJ — centrifugal-flow turbjet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp — gas horsepower
lb. t. — pounds thrust
¹ — Lb /hr /lb thrust
² — Lb /hp /hr
³ — Lb /hr

ALLEGHENY AIRLINES NAPIER ENGINE CONVAIR 540

Circle Number 190 on Reader-Service Card

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Max. takeoff power (hp.)—SL	At rpm	Normal rated power (hp.)	At rpm	At altitude (ft.)	Fuel grade	Diameter or dimensions, in. (without cowling)	Blower ratio	Gross weight dry (lb.)
Aircooled Motors, Inc. Syracuse, N. Y.	4A4-100-B3	4	Ho	Direct	100	2 550				80			200
	6A4-150-B3	6	Ho	Direct	160	2 900				80			278
	6A4-165-B3	9	Ho	Direct	166	2 800				80			278
	6AG4 185-B12	9	Ho	G .632 1	188	2 100				80			282
	6A4-200-C6	9	Ho	Direct	200	3 100				91			307
	6V4-200-C32 C33 O335-5, -6	9	Vo	Direct	206	3 100				91			287
	6VS-245-B 19F O425-1	9	Vo	Direct	245	3 275				80			372
	6V-335-A -B	6	Vo	Direct	219	3 100				91			290
	6VS-335	9	Ho	Direct									
Avco Manufacturing Corp Lycoming Division Stratford, Conn.	O-235-C1	4	Ho	Direct	115	2 800	88	2 350	1 500	80	22 33x32		237
	O-290-D2B	4	Ho	Direct	140	2 800	106	2 350	1 500	80 87	22 81x32 24		264
	O-320-A2B	4	Ho	Direct	150	2 700	110	2 450	7 000	80 87	23 12x32 24		272
	O-320-B2B	4	Ho	Direct	160	2 700	120	2 450	7 000	91 96	23 12x32 24		278
	O-340-A1A	4	Ho	Direct	170	2 [illegible]	100	2 100	7 500	91 96	24 55x32 56		[illegible]
	O-350-A1A	4	Ho	Direct	180	2 700	150	2 450	7 500	91 96	24 72x33 37		285
	O-360-B1A	4	Ho	Direct	180	2 700	100	2 150	7 000	80 87	24 50x33 37		278
	O-360-C2B	4	Ho	Direct	180	2 700	145	2 400	7 500	91 96	19 99x33 37		280
	O-540-F1B5	9	Ho	Direct	260	2 800	235	2 500	1 000	91 96	24 56x33 37		398
	VO-360-A1A	4	Vo	Direct	180	2 500	145	2 300	1 500	91 96	21 92x23 37		398
	VO-435-A1F	9	Vo	Direct	275	3 400	200	3 200	7 500	80 87	31 73x32 68		397
	VO-540-B1B, -B1C	9	Vo	Direct	315	3 200	245	3 200	1 500	80 87	24 87x34 14		450
	GO-435-C2B2-6	9	Ho	Gear	260	3 400	190	2 [illegible]50	6 500	80 87	28 02x33 12		430
	GO-480-B1A6, -B1D	9	Ho	Gear	270	3 400	193	2 [illegible]50	7 500	80 87	28 02x33 12		432
	GO-480-G1A6	9	Ho	Gear	295	3 400	219	2 750	7 500	100 130	28 02x33 12		439
	GO-480-G1B6	9	Ho	Gear	295	3 400	219	2 750	7 500	100 135	27 16x33 12		454
	GO-480-G2D6	9	Ho	Gear	300	3 400	219	2 750	9 500	100 130	28 07x33 12		417
	GSO-480-B1A6	9	Ho	Gear	340	3 400	249	2 750	12 500	100 130	33 09x33 12		498
	GSO-480-B1B6 (O-480-1)	9	Ho	Gear	340	3 400	249	2 750	12 500	100 130	33 29x33 12		500
	GSO-480-B1C6	6	Ho	Gear	340	3 400	249	2 750	10 500	100 130	22 60x33 12		[illegible]
	GSO-480-B2D6	9	Ho	Gear	340	3 400	249	2 [illegible]50	12 500	100 130	22 36x33 12		498
	O-540-A1B5, -A1C5	9	Ho	Direct	255	2 600	100	2 300	1 500	91 96	25 58x33 37		397
	SO-580-A1B (O-580-3)	8	Ho	Direct	100	3 300	600	3 400	11 500	100 130	24 59x33 12		578
	IGSO-480-A1A6	9	Ho	Gear	340	3 400	319	2 750	12 500	100 130	23 29x33 12		496
	IMO-360-A1A	4	Ho	Direct	180	2 700	130	2 450	7 500	91 96	17 47x33 37		291
Continental Motors Corp Muskegon, Mich.	O-200-A	4	Ho	Direct	100	2 750				80 87			190
	GO-300-A, B & C	9	Ho	G .750 1	175	3 200				80 87			311
	IO-470-C	9	Ho	Direct	250	2 600				80 87			412
	IO-470-D, E & F	9	Ho	Direct	260	2 625				100 130			488
	A65-8	4	Ho	Direct	65	2 300				80 87			175
	C85-12F	4	Ho	Direct	85	2 575				80 87			184
	C90-12F	4	Ho	Direct	95	2 625				80 87			188
	O-300-A, B & C	9	Ho	Direct	145	2 700				80 87			268
	O-470-G	9	Ho	Direct	240	2 600				91 96			432
	O-470-H	9	Ho	Direct	240	2 600				91 96			432
	O-470-J	9	Ho	Direct	225	2 550				80 87			378
	O-470-K	9	Ho	Direct	230	2 600				80 87			404
	O-470-L	9	Ho	Direct	230	2 600				80 87			404
	O-470-M	6	Ho	Direct	240	2 600				91 96			416
	FSO-526-A	9	Ho	Direct	270	2 200	270	3 000	7 500	91 96		19 64	553
	GSO-526-A	9	Ho	G .588 1	340	3 100	300	3 000	14 500	100 130		12 88	558
	O-470-4	9	Ho	Direct	225	2 600				91 96			415
	O-470-15	9	Ho	Direct	213	2 300				80 87			428
	E-185-9	6	Ho	Direct	200	2 600				80 87			357
	E-225-4	9	Ho	Direct	225	2 650				80 87			358
Pratt & Whitney Aircraft Div United Aircraft Corp East Hartford, Conn.	R2000-D1	14	Rad	G .500	1 100	2 700	1 000	2 550	6 400	100 130	49 19	7 15	1 585
	R2000 2SD13-G	14	Rad	G .500	1 450	2 700	1 050	2 550	5 000	100 130	49 19	7 15 46 82	1 605
	R2800-CB3	18	Rad	G .450 1	2 400	2 800	1 800	2 500	8 500	100 130	52 80	7 29	2 257
	R2800-CB4	18	Rad	G .450 1	2 500	2 800	1 900	2 600	8 500	108 135	52 80	7 29	2 257
	R2800-CB16	18	Rad	G .450 1	2 100	2 800	1 800	2 500	8 500	100 130	52 80	7 29+8 36	2 300
	R2800-CB17	18	Rad	G .450 1	2 500	2 800	1 800	2 500	8 500	108 135	52 80	7 29+8 36	2 300
	R2800-CB2	18	Rad	G .450 1	2 500	2 800	1 800	2 600	7 000	115 145	52 8	7 29	2 270
	R2800-CB3 -51	18	Rad	Direct	2 100	2 700	1 900	2 600	1 000	115 145	50 8	7 29	2 230
	R2800-CB15 -99W	18	Rad	G .450 1	2 500	2 800	1 900	2 600	7 500	115 145	52 8	7 29+8 36	2 403
Wright Aeronautical Div Curtiss-Wright Corp Wood-Ridge, N. J.	749I 18BD1 / R3350-75	18	Rad	G .4375 1	2 550	2 900	2 100	2 400	1 400	100 130	55 93	9 46[1]	2 315
	820C9HD340 / R1820-76A-76B	9	Rad	G .5625 1	1 425	2 700	1 275	2 500	3 000	100 130	55 07	7 21[1]	1 380
	830L18CA2 / R3350-26WB	18	Rad	G .4375 1	2 700	2 900	2 300	2 500	8 200	115 145	55 8	9 40[1]	2 958
	833C7BA1 / R1300-1A	7	Rad	G .5625 1	800	2 800	700	2 400	5 500	91 98	50 45	7 21	1 090
	839TC18DB1, 2, 3	18	Rad	G .4375 1	3 500	2 900	2 500	2 800	9 500	115 145	56 9	9 40[1]	3 390
	863C9HD1 / R1820-103	9	Rad	Direct	1 425	2 700	1 275	2 500	3 500	100 130	54 00	7 21[1]	1 350
	865C7BA1 / R1300-3B	7	Rad	Direct	800	2 800	700	2 400	5 500	91 98	50 45	7 21	1 080
	867C9HE1, -2 / R1820-82-82A	9	Rad	G .5625 1	1 525	2 800	1 275	2 500	3 500	115 145	55 74	7 21	1 469
	871C7BA1 / R1300-3	7	Rad	Direct	800	2 600	700	2 400	5 500	91 98	50 45	7 21	1 090
	872TC18DA1 / R3350-34	18	Rad	G .4375 1	3 250	2 900	2 600	2 600	9 500	115 145	56 6	9 40[1]	3 511
	878TC18EA1, 2 / R3350-32W, -32WA	18	Rad	G .4375 1	3 700	2 900	2 800	2 500	4 100	115 145	56 9	6 46[1]	3 560
	886C9HE1, 2, 3 / R1820-84, 84A, 84B	9	Rad	Direct	1 525	2 800	1 275	2 500	3 500	115 145	55 74	7 21	1 410
	890C9HD1 / R1820-86	9	Rad	G .5625 1	1 425	2 700	1 275	2 600	3 100	100 130	55 07	7 21[1]	1 385
	923TC18DA1 / R3350-91	18	Rad	G .4375 1	3 350	2 900	2 500	2 900	9 500	115 145	56 9	9 46[1]	3 782
	912TC18EA1 / R3350-38	18	Rad	G .355 1	3 400	2 900	2 800	2 650	4 500	115 145	56 9	9 40[1]	3 582
	937C7BA1	7	Rad	G .5625 1	800	2 800	700	2 400	7 500	91 98	50 45	7 21	1 065
	958C9HE1 2	9	Rad	G .5625 1	1 475	2 800	1 275	2 500	3 500	100 130	51 93	7 21	1 350
	972TC18DA1, 2	18	Rad	G .4375 1	3 250	2 850	2 500	2 600	9 300	115 145	56 6	9 46[1]	3 581
	975C18CB1	18	Rad	G .4375 1	2 800	2 900	2 100	2 800	1 500	115 145	56 9	9 40[1]	3 065
	977C9HD1, 2, 3	9	Rad	Direct	1 425	2 700	1 275	2 500	2 500	100 130	55 78	7 21[1]	1 310
	985C9HE1	6	Rad	G .5625 1	1 525	2 800	1 275	2 500	3 400	115 145	55 75	7 21[1]	1 455
	988TC18EA1	6	Rad	G .786 1	1 125	2 750	1 275	2 500	2 300	100 130	51 95	6 40[1]	1 271
	988TC18EA2	18	Rad	G .4275 1	3 100	2 900	2 800	2 500	4 700	115 145	56 59	9 46[1]	3 615
	989C9HE12	18	Rad	G .355 1	3 100	2 900	2 800	2 800	4 700	115/145	56 59	7 21	3 718
	941C9HE1 / R1820-82WA	9	Rad	Direct	1 525	2 800	1 275	2 500	3 500	115 145	55 74	7 21	1 296
	918C9HE1 / R1820-88	9	Rad	G .5625 1	1 525	2 800	1 275	2 500	3 500	115 145	55 74	7 21	1 484
	R1820-90-90A	3	Rad	G .355 1	1 525	2 800	1 275	2 600	2 500	115 145	55 74	7 21	1 479
	981TC18EA1 / R3350-42	9	Rad	Direct	1 455	2 800	1 275	2 500	2 500	115 145	55 74	7 21	1 472
	981TC18EA1	18	Rad	G .4375 1	3 400	2 900	2 500	2 500	9 500	115 145	56 59		3 730
	990C7BA1	18	Rad	G .4375 1	3 700	2 900	2 800	2 500	4 700	115 145	56 59		3 651
	990C9HE1, 2	7	Rad	Direct	800	2 800	700	2 400	7 500	91 98	50 45	7 21	1 079
		9	Rad	Direct	1 525	2 800	1 275	2 500	3 500	115 145	55 75	7 21	1 401

G —Geared Ho —Horizontally opposed Rad —Radial SL —Sea level Vo —Vertically opposed [1] For helicopter installation

U. S. Personal and Business Aircraft

Manufacturer and Address	Designation	No. of seats	Over-all span	Over-all length	Max. height, 3-pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Number, make, model and max. rating, ea.	Normal fuel capacity, gal.	Max. speed, mph.	Landing speed, mph	FAA field length (takeoff), ft	FAA field length (landing), ft	Max. range, mi	Price, FAF, $
	Base Data								Powerplants	Performance						
Aero Design & Engr'g Co *Bethany, Okla*	Aero Commander 500	*	49	35' 4"	14' 6"	255	3 850	6 000	2 Lyc O540-A1A @ 250 hp.	156	218	70	1 450	1 350	1 100	84 [illegible]
	Aero Commander 560F	7	49	35' 1"	14' 6"	255	4 300	6 000	2 Lyc GO480-C1B6 @ 295 hp	223	270	70	2 010	1 485	1 000	78 400
	Aero Commander 680F	7	49	35' 1"	14' 6"	255	4 485	7 000	2 Lyc GSO480-B1A6 @ 340 hp	223	255	70	1 600	1 705	1 180	94 500
	720 Alti-Cruiser	5	49	35' 4"	14' 6"	255	5 230	7 500	2 Lyc GSO480-B1A6 @ 340 hp.	223	270	70	1 600	1 650	1 450	183 750
Aircraft Marine Engr'g Corp *Van Nuys Calif*	A-1 Annet	9	46	30	11	260	4 000	7 000	2 Fai 420-M @ 1 200 lb. t	450	490	43	650	850	1 650	100 000
	A-2 Annet	20	72'	60	15	530	10 250	14 000	4 Fai 420-M @ 1 000 lb. t	1 600	450	18	2 500	1 500	2 600	500 000
Bee Aviation Assoc., Inc *San Diego Calif*	Queen Bee	4	32'	21' 10"	7' 7"	150	1 250	2 300	1 Lyc A360 @ 180 hp	42	160	55	850	700	650	
	Honey Bee	1	28	18' 10"	7' 6"	86	610	880	1 Con A65 @ 65 hp	8.0	120	45	700		540	
Beech Aircraft Corp. *Wichita Kansas*	Super 18 (G18s)	9	49' 8"	35' 3"	9' 5"	360.7	5 900	9 700	2 P&W R985-AN14B @ 450 hp.	318	234	84	1 490	1 350	1 585	126 000
	Queen Air 65	7	45' 8"	33' 3"	14' 1"	277.06	4 710	7 700	2 Lyc IGSO-480-A1A6 @ 340 hp	230	239	80	1 560	1 685	1 145	120 000
	Twin Bonanza (H50)	6	45' 3.25"	31' 6"	11' 4"	277.06	4 180	7 300	2 Lyc IGSO-480-A1A6 @ 340 hp.	230	235	82.5	1 450	1 410	1 650	35 000
	Twin Bonanza (D50C)	6	45' 3.25"	31' 6"	11' 4"	277.06	4 180	6 300	2 Lyc GO-480-G2D6 @ 295 hp	180	214	71	1 300	1 455	1 650	85 500
	Travel Air B95	4	37' 8"	25' 3"	9' 6"	199.2	2 635	4 100	2 Lyc O-360-A1A @ 180 hp.	112	210	70	1 280	1 550	1 410	49 000
	Bonanza M35	4	33' 5.5"	25' 1"	6' 6"	181	1 832	2 950	1 Con IO-470-C @ 250 hp.	50	210	60	970	400	1 245	25 300
	Debonair 33	4	32' 8"	25' 5"	8' 3"	177.6	1 730	2 900	1 Con IO-470-J @ 225 hp.	50	195	60	890	670	1 170	19 995
Call Air, Inc *Afton Wyo*	A-6	2	35' 6"	23' 9"	7' 10"	156	1 020	2 150	1 Lyc O320-A2A @ 150 hp.	35	104	42	620	450	328	
	A-5	2	35' 6"	24'	7' 10"	156	1 170	2 350	1 Lyc O360-A1A @ 180 hp	40	107	40	750	150		
Cessna Aircraft Co. *Wichita Kansas*	150	2	33' 4"	21' 11"	6' 11"	160	916	1 500	1 Con O200-A @ 100 hp.	26	124	50	1 385	1 055	575	7 250
	172	4	36	26' 1"	8' 11"	174	1 250	2 200	1 Con O-300-C @ 145 hp	42	140	52	1 370	1 110	700	9 450
	175	4	36	26' 6"	8' 6"	174	1 330	2 350	1 Con GO-300-C @ 175 hp.	52	147	51	1 140	1 155	735	11 500
	180	4	36	26	7' 6"	174	1 530	2 650	1 Con O-470-L @ 230 hp.	65	170	50	1 080	1 320	845	14 675
	182	4	36	27' 1"	9' 0"	175	1 560	2 550	1 Con O-470-L @ 230 hp.	65	167	56	1 080	1 310	835	14 890
	Skylane	4	36	27' 1"	8' 0"	175	1 632	2 650	1 Con O-470-L @ 230 hp.	65	170	50	1 060	1 310	845	17 325
	310D	5	35' 9"	29' 7"	10' 11"	175	3 03[illegible]	4 830	2 Con IO-470-D @ 260 hp	102	218	74	1 395	1 700	1 440	59 950
	Skylark	4	36	26' 0"	8' 6"	174	1 420	2 350	1 Con GO-300-C @ 175 hp	52	149	51	1 210	1 165	748	15 050
	210	4	36' 7"	27' 9"	9' 8"	175.5	1 735	2 900	1 Con IO-470-E @ 260 hp	65	190	50	1 135	1 190	1 100	22 450
Champion Aircraft, Inc. *Osceola Wisc*	7EC Traveler	2	35' 2"	21' 6"	5' 2"	170	860	1 450	1 Con C90-12F @ 95 hp	20	115	38	600	350	600	[illegible] 330
	7FC Tri-Traveler	2	35' 2"	21' 9"	7' 2"	170	930	1 450	1 Con C90-12F @ 95 hp	60	115	44	900	350	500	6 595
	7GC Sky-Trac	2	35'	21' 11"	7' 2"	170	930	1 550	1 Lyc O290-D2B @ 140 hp	20	125	40	800	350	600	7 530
	7HC DX'er	3	35'	21' 11"	7'	164	1 000	1 650	1 Lyc O290-D2B @ 140 hp	60	125	48	350	350	580	8 120
Downer Aircraft Ind., Inc. *Alexandria Minn*	Bellanca 260 (Model 14-19-3)	4	34' 2"	22' 11"	6' 4"	161.5	1 600	2 700	1 Con IO-470-F @ 250 hp	40	208	45	300	400	950	18 950
Fletcher Aviation Corp *Rosemead Calif*	FL-24 Utility	9	42	31' 10"	9' 4"	294	1 890	3 500	1 Con O470-N @ 240 hp	44	130	40			410	24 290
Forney Aircraft *Fort Collins Colo*	Fornaire F-1 (Ercoupe Expediter)	2	30	20' 2"	6' 3"	143	920	1 400	1 Con C90-12F @ 95 hp.	24	120	68	500	600	500	
Grumman Aircraft Engr'g Corp. *Bethpage N.Y.*	159 Gulfstream	14	78' 6"	64'	22' 9"	610	20 134	32 500	2 Rolls-Royce RDa. 7/2 @ 2 105 eshp.	1 604	350	94	3 850	1 550	2 050	
	164 Crop Duster	1	35' 8"	24' 4"	10' 9"	326	2 170	3 800	1 Con W670 @ 220 hp	34	110					19 500
Helio Aircraft Corp *Norwood Mass*	H395A Courier	5	39	30'	8' 10"	231	2 020	3 000	1 Lyc GO-435-C2B2 @ 260 hp	60	160	30	155	485	780	31 180
	H395 Super Courier	5	39	30'	8' 10"	231	2 037	3 000	1 Lyc GO-480-G1D6 @ 295 hp.	60	165	30	475	475	842	31 980
Lake Aircraft Corp *Sanford Me*	C-2 Skimmer	4	34	23' 6"	8'	150	1 500	2 350	1 Lyc O360 @ 180 hp.	40	140	52			600	24 595
Lockheed Aircraft Corp *Marietta Ga*	1329 Jet Star	10	53' 8"	60' 5"	20' 6"	543	18 450	38 950	4 P&W JT12A-6 @ 3,000 lb. t.	2 830	578	136	5 820	4 000	2 310	1 000 000
McDonnell Aircraft Corp. *St. Louis Mo*	Model 119	12	57' 7"	66' 8"	22' 8"	550		45 928	4 P&W JT12 @ 3,000 lb. t		565	108			2 335	
Myers Aircraft Co *Tecumseh Mich*	Myers 200A	4	30' 6"	24' 5"	8' 3"	161	1 810	3 000	1 Con IO-470-D @ 260 hp	40						
Mooney Aircraft, Inc *Kerrville Tex*	Mark 20-A	4	35'	23'	8' 0"	167	1 150	2 450	1 Lyc O360 @ 180 hp.	46	165	67			1 000	15 450
Piper Aircraft Corp. *Lock Haven Pa*	PA-18 "95"	2	35' 3"	22' 4"	6' 7"	178.5	900	1 500	1 Con C90 @ 95 hp	18	112	42	730	800	360	6 145
	PA-18 "150"	2	35' 3"	22' 6"	6' 7"	178.5	930	1 750	1 Lyc O320 @ 150 hp	36	130	43	500	725	460	7 795
	PA-18A Super Cub	1	35' 3"	22' 5"	6' 7"	178.5	1 000	2 070	1 Lyc O320 @ 150 hp.	36	105	45	450	875	300	8 045
	PA-22 Caribbean	4	29' 3"	20' 6"	8' 1"	147.5	1 100	2 000	1 Lyc O320 @ 150 hp	36	139	49	1 220	500	500 +	8 795
	PA-22 "160" Tri Pacer	4	29' 3"	20' 7"	8' 4"	147.5	1 110	2 000	1 Lyc O320-B @ 160 hp.	36	141	49	900		536	9 345
	PA-23 "160" Apache	3-5	37'	27' 2"	9' 6"	204	2 230	3 500	2 Lyc O320-B @ 160 hp	72	182	50	900	870	855	38 850
	PA-24 "180" Comanche	4	36'	24' 8"	7' 4"	178	1 515	2 550	1 Lyc O360-A1A @ 180 hp.	50	167	58	750	600	600	15 800
	PA-24 "250" Comanche	4	36'	24' 11"	7' 4"	178	1 600	2 800	1 Lyc O540-A1A @ 250 hp.	60	190	64	750	600	1 100	19 800
	PA-25 Pawnee	1	36' 2"	24'	8' 8"	183	1 200	2 300	1 Lyc O320 @ 150 hp.	38	100	57	825	400	490	9 500
	PA-23 "250" Aztec	5	37'	27' 0"	10' 3"	207	2 775	4 800	2 Lyc O540 @ 250 hp.	144	215	62	750	500	1 400	45 500
Stits Aircraft *Riverside Calif*	SA9A Skycoupe	2	28' 4"	17' 8"		128	800	1 350	1 Con. [illegible]	24	145	60	460	500	500	4 000
Taylorcraft, Inc. *Conway Pa*	Zephyr	4	34' 5"	24' 4"	7' 2"	176	1 200	2 750	1 Con O470-J @ 225 hp.	66	150	60	450	700	750	
	Topper	1	34' 8"	24' 4"	7' 2"	176	1 631	2 750	1 Con O470-J @ 225 hp.	40	110	70	600	600	450	
Transland Aircraft *Torrance Calif*	AG 2	1	42'	28' 5"	9' 8"	321	3 330	6 000	1 P&W R1340 @ 600 hp.	125	144	61	500	500		
Trecker Aircraft Corp *Milwaukee Wisc*	Trecker 166	8	46' 8"	38' 1"	15' 5"	296	5 104	8 100	2 Lyc GSO-480-A1C6 @ 340 hp	232.5	220	69	1 350	1 312	1 165	145 250
	Gull Amphibian (L-1)	6	44' 5"	35' 5"	12' 7"	270	4 420	6 000	2 Lyc GO-480-B1 @ 270 hp.	130	184	72	1 350	1 410	590	74 800
	Gull Amphibian (L-2)	6	44' 5"	35' 9"	12' 7"	270	4 690	6 615	2 Lyc GSO-480-A1A6 @ 310 hp	190	213	72	1 440	1 800	994	60 500

U. S. Civil and Military Transports

Manufacturer and Address	Model	Name	No. of crew	No. of passengers	Cargo capacity lb.	Number, make, model of powerplants	Maximum speed, mph	Best cruise speed, mph	Landing speed flaps and landing gear down, mph	Engine-out en route climb, fpm	FAA field length takeoff ft	FAA field length landing ft	Maximum still-air range, mi.	Weight empty lb.	Maximum gross weight lb.	Maximum landing weight lb.	Wingspan	Overall length	Maximum height
Boeing Airplane Co. *Renton Wash*	707	Jet Stratoliner[1]	3			4 P&W JT3-6[1]	610	600					1 000	111 052	183 000	175 000	130'	128'	38' 8"
	707-120	Jet Stratoliner	4	100-179	15 200	4 P&W JT3C-6[2]	610	593					1 000	111 840	254 000	185 000	130' 10"	144' 6"	38' 8"
	707-220	Jet Stratoliner	4	100-179	15 200	4 P&W JT4A-3	600	545					4 000	117 400	248 000	175 000	130' 10"	144' 6"	38' 8"
	707-320	Intercontinental	4-6	105-189	28 200	4 P&W JT4A-11	600	540					5 000	137 221	316 000	207 000	142' 5"	152' 11"	38' 8"
	707-420	Intercontinental	4-6	104-189	28 200	4 R-R Co. 12	606	506					5 000	131 248	316 000	207 000	142' 5"	152' 11"	38' 8"
	720		4	88-115	16 585	4 P&W JT3C-7	640	544					3 390	108 763	203 000	175 000	130' 10"	136' 2"	38' 2"
	KC-135A	Stratotanker	4	80+	80 000	4 P&W J57	600+								250 000		130' 10"	136' 3"	38' 8"
	VC-137A[1]																130' 10"	144' 6"	38' 8"
	707-120B	Jet Stratoliner	3-4	100-179	15 200	4 P&W JT3D-1								120 731	258 000	185 000		144' 6"	38' 8"
	720B	Jet Stratoliner	3-4	88-165	17 080	4 P&W JT3D-1								110 778	230 000	175 000		136' 2"	38' 8"
	735		3-4		100 000	4 P&W JT3D									316 000			152' 11"	38' 8"
Convair Division General Dynamics Corp *San Diego Calif*	880		3	84-110	8 630	4 GE CJ805-3	610		133		5 220	5 460	3 050	91 900	184 500	142 800	120'	129' 4"	36'
	990		3	90-121	4 280	4 GE CJ805-23	990		125		5 700	4 770	1 100	113 300	239 000	190 000	120'	139' 6"	39' 5"
	440	Metropolitan	3	44-52	5 400	2 P&W R-2800-CB-17	340	289	85	150	5 000	4 010	2 752	31 385	49 100	47 650	105' 4"	79' 2"	28' 2"
	C-131A	Samaritan	3			2 P&W R-2800-99W	312							29 000	14 375		91' 9"	74' 8"	27' 3"
	T-131B					2 P&W R-2800-99W	295							29 248	47 000		105' 4"	79' 2"	28' 2"
	YC-131C					2 All. YT56-A-3	346								47 000		105' 4"	79' 2"	28' 2"
	C-131D		3			2 P&W R-2800-CB-16	314							29 000	46 500		105' 4"	79' 2"	28' 2"
	R3Y-2	Tradewind	6			4 All. T40-A-10	350							71 835	165 000		145' 9"	139' 8"	51' 5"
	R4Y-1		3			2 P&W R-2800-52W								30 684	47 000		105' 4"	79' 2"	28' 2"
Douglas Aircraft Co., Inc. *Long Beach Calif*	DC-8	Series 10	3	116-176	20 850	4 P&W JT3C-6		565	118		8 330	6 100	4 170	120 049	273 000	193 000	142' 5"	150' 6"	42' 4"
	DC-8	Series 20	3	116-176	20 850	4 P&W JT4A-3		588	148		8 300	6 100	4 250	123 757	276 000	193 000	142' 5"	150' 6"	42' 4"
	DC-8	Series 30	3-5	116-176	20 850	4 P&W JT4A-3		588	150		10 000	6 550	5 400	126 072	310 000	199 500	142' 5"	150' 6"	42' 4"
	DC-8	Series 40	3-5	116-176	20 850	4 R-R Co. 12		593			9 870	6 560	6 450	124 [illegible]			142' 5"	150' 6"	42' 4"
	DC-8	Series 50	3-5	116-176	20 850	4 P&W JT3D-3		585	150		[illegible]	6 500	6 900	124 522	310 000	199 500	142' 5"	150' 6"	42' 4"
	DC-8	Intercontinental	3-5	116-176		4 R-R Conway R. Co. 10		591						128 000	287 000		134' 9"	150' 6"	42' 4"
	DC-6[5]																		
	DC-7C	Seven Seas	3-5	60-99	18 110	4 Wr. 988TC-18EA1	406	371		907	5 890	5 200	6 010	72 763	143 000	109 000	127' 6"	112' 3"	31' 10"
	DC-7B	Extended range	3	60-99	17 730	4 Wr. 972TC-18DA4	410	360		535	7 150	5 870	6 120	66 073	126 000	102 000	117' 6"	108' 11"	28' 7"
	DC-7	Domestic	3	60-99	12 740	4 Wr. 972TC-18DA4	406	367		445	6 060	5 840	4 430	64 480	122 000	95 000	117' 6"	108' 11"	28' 7"
	DC-6C	Extended range	4	80	11 950	4 P&W R2800-CB-17	370	310	87	135	5 150	5 160	5 000	55 110	107 000	88 200	117' 6"	105' 7"	28' 8"
	DC-6B	Domestic	5	54	16 780	4 P&W R2800-CB-16	370	315	95	490	5 850	4 965	3 720	55 357	100 000	88 000	117' 6"	105' 7"	28' 8"
	DC-6A	Liftmaster	3-5	Cargo	30 000	4 P&W R2800-CB-17	370	315	87	483	6 100	5 160	5 000	51 316	107 000	88 200	117' 6"	105' 7"	28' 8"
	C-124C	Globemaster 2	6-8	Cargo		4 P&W R4360-63A	304							101 165	185 000		174' 2"	130' 5"	48' 4"
	C-133A	Cargomaster 1	4-7	Cargo	62 000	4 P&W T34							3 070		282 000	282 000	179' 8"	157' 6"	48' 3"
	C-133B	Cargomaster 2	4-7	Cargo	77 880	4 P&W T34-P-9W	312							120 263	300 000	286 000	179' 8"	157' 6"	48' 3"
Fairchild Aircraft Division Fairchild Engine & Aircraft Corp *Hagerstown Md*	F27		3	40	10 030	2 R-R R. Da. 6 mk 511	272	272	78	340	4 000	3 345	2 128	23 070	37 000	34 000	95' 2"	77' 1½"	27' 6"
	F27A		3	40	9 067	2 R-R R. Da. 7 mk 528	300	300	74	180	3 420	3 345	1 855	24 550	37 500	36 000	95' 2"	77' 1½"	27' 6"
Grumman Aircraft Engr. Corp. *Bethpage, L. I. N. Y.*	TF-1	Trader	2	9	3 500	2 Wr. R1820-82								16 858	24 449		69' 8"	42'	16' 0"
Lockheed Aircraft Corp Marietta (Ga.) Division	1329	Jetstar	2	8	2 440	4 P&W JT12A-6	575	560	120	2 200	5 820	4 000	2 310	18 150	38 940	29 000	53' 8"	60' 5"	20' 6"
	CL-329-21	Jetstar	2			4 P&W J-60-P-3	600	560	110	2 500	5 820	4 000	2 310	18 000	41 791	30 000	53' 8"	60' 5"	20' 6"
	C-130A	Hercules	4	92	36 000	4 All. T56-A-1A or T56-A-9	374	350	117				2 110	59 300	124 200	124 200	132' 7"	97' 9"	38' 4"
	GV-1 130A[6]	Hercules	6			4 All. T56-A-9	378	335	90	1 000			578[7]	62 400	124 200	121 200	132' 7"	97' 9"	38' 4"
	RC-130A[8]	Hercules	8	24		4 All. T56-A-9	378	350	112	1 450			2 110	63 160	124 200	121 200	132' 7"	97' 9"	38' 4"
	C-130B	Hercules	4	92	35 000	4 All. T56-A-7	385	350	118				2 150	67 300	135 000	135 000	132' 7"	97' 9"	38' 4"
	SC-130B[9]	Hercules	8	44	35 000	4 All. T56-A-7	383	360	116				2 165	67 200	135 000	135 000	132' 7"	97' 9"	38' 1"
	GV-1	Hercules	5	92	32 000	4 All. T56-A-7	385	350	112				3 030	72 900	135 000	135 000	132' 7"	97' 9"	38' 1"
	C-130D	Hercules	4	92	30 600	4 All. T56-A-1A or T56-A-9	370	335	112				1 900	65 799	124 200	121 200	132' 7"	97' 9"	39' 1"
	C-130B[10]	Hercules	4	92	31 600	4 All. T56-A-7	370	345	116				2 100	73 300	135 000	135 000	132' 7"	97' 9"	38' 3"
Burbank Calif Div	188	Electra	3-4	66-98		4 All. 501-D-13	450	405	130	730	4 200	4 660	3 100	55 334	116 000	95 650	99'	104' 6"	32'

[1] Prototype
[2] Wet engine.
[3] Dry engine.
[4] Three aircraft ordered for USAF Special Mission Squadron
[5] DC-6 DC-7 series production discontinued in 1958 after total of 1041 of all models built.
[6] Drone launcher
[7] Combat radius, includes four-hours loiter
[8] Photographic survey missions
[9] U. S. Coast Guard search and rescue version
[10] Design study dropped when Caravelle licensed

BOEING 707-720 DELIVERY LINE

U. S. STOL & VTOL Aircraft

Manufacturer and Address	Designation	Type	No. of seats	Span	Length	Height	Wing area, sq. ft.	Empty weight, lb.	Gross weight, lb.	Number, make, model and max. power, ea.	Rotor-propeller diameter	No. of propellers	Service ceiling, ft.	Maximum speed, m.p.h.	Remarks
Curtiss-Wright Corp. *Santa Barbara, Calif.*	VZ-7AP	Ducted fan	2	15' 6"¹	18' 2"	7' 7"	135	1,800	2,840	1 Con. Artouste IIB 400 hp.	6' 6"				Flight demo. with 57 mm. recoilless rifle.
Bell Aircraft Corp. *Buffalo, N.Y.*	X-14	Deflected jet	1	34	27'	9				2 AS Viper	N.A.	None			VTOL flight cycle May 24, 1958
	D-188A	Tilt jets Ducted Fan	1							8 GE J85-6 2,600 lb. t.	N.A. N.A.	None		M2+	Twin jets at each wingtip, 2 in fuselage, 2 in tail.
Bell Helicopter Corp. *Fort Worth, Tex.*	XV-3	Tilt rotor	4	25	30'	13' 8"	120	3,400	4,700	1 P&W R985@450 hp.	23'	2	7,400²	184	Rotor diameter (2) 23 ft.
Benson Aircraft Corp. *Raleigh, N.C.*	B-10	Prop-Copter	1	7' 2"¹	12	4' 6"		350	590	2 McCulloch 4318-E 72 hp.	4' 3"	2		60	First flight Aug. 6, '58
	B-8m	Gyrocopter	1	21	21	6' 4"		280	500	1 McCulloch 4318E 72 hp.	21'		10,300	85	
Chrysler Corp. Defense Ops. Div. *Detroit, Mich.*	VZ-6	Ducted fan	1	10'¹	23'	4' 0"			2,300	1 Lyc. @ 380 hp.	8' 0"	2			Rigid fixed-pitch rotor props.
Collins Radio Co. *Cedar Rapids, Ia.*	Aerodyne	Ducted fan			43'					2 Con. @ 310 hp					Duct inside diameter 7.5 ft.
Convertawings, Inc. *Amityville, N.Y.*	V-16 Quadrofoil	Tilt wing	6	Tandem¹	23' 8"	8' 9"	150	6,710	4,852	1 GE T58 @ 1,000 shp.	96"	4	12,000²	312	Prototype building
De Lackner Helicopters, Inc. *Mt. Vernon, N.Y.*	DH-4 Aerocycle DH-5 Aerocycle		1 1	10						1 Kiek. Mercury @ 40 hp.	160	2			Several on bailment to universities.
Doak Aircraft Co., Inc. *Torrance, Calif.*	VZ-4DA	Tilt ducts	2	25	32	10'		2,000	2,700	1 Lyc. T53 @ 840 shp.		2			600 lb. useful load
Fletch-Aire, Inc. *Newton, N.J.*		Ducted fan Ducted fan	1 4				58		1,500 8,000	2 engines @ 115 hp. 2 Lyc. T53 @ 840 shp.			37,500	238 218	Duct rotates 90 deg. Projected weapons carrier
Helio Aircraft Corp. *Norwood, Mass.*	L-28A		6	39'	30'	8' 10"	231	2,037	3,300	1 Lyc. GO480@260 hp.	96"	1	22,500	166	In production
Hiller Aircraft Corp. *Palo Alto, Calif.*	X-18	Tilt wing	2	48'	63	24' 7"		33,000		2 All. YT40-A-14	192"	2		260	Testbed for USAF
Kaman Aircraft Corp. *Bloomfield, Conn.*	K-16B	Tiltwing deflected slipstream & propulsive rotor		33'	40' 4"	17' 2"	234.9			2 GE T58 @ 1,000 shp.	168"	2			Navy flight research a/c.
Lanier Aircraft Corp. *Marlton, N.J.*	Paraplane Paraplane	Boundary layer Boundary layer	1 4	20' 7" 27' 11"	21 22' 11"	 8' 6"	111	760 1,200	1,280 2,260	1 Lyc. O320 @ 150 hp. 1 Lyc. O360 @ 180 hp.		1 1	23,000 21,500	165 171	Prototype flying. Project.
McDonnell Aircraft Corp. *St. Louis, Mo.*	XV-1	Convertaplane unloaded rotor	3	26'	30'	10' 8"				1 Con. @ 550 hp. + tip jets					Translated Apr. 1955
Leonard Mueller *Eau Claire, Wisc.*	Travcar X-2	Ducted fan	4	20'¹	10'	5' 10"		883	1,800	1 Aircooled V8 @ 145 hp.	120"	2		135	Design study
Piasecki Aircraft Corp. *Philadelphia, Pa.*	VZ-8P	Ducted fan	1					2,000	2,500	1 Con. Artouste IIB 400 shp.					Tactical ground support.
	59H		4					2,800	4,670	2 Con. Artouste IIB 420 shp.					
	BRP		12	41	39' 3"	18' 1"		4,720	7,000	2 Con. Artouste IIB 420 shp.	14		16,000²	110	
Robertson Aircraft Corp. *Ft. Worth, Tex.*		Vectored slipstream	4							2 Lyc. GSO 480 @ 340 hp.		2			Range about 1,000 mi.
Ryan Aeronautical Co. *San Diego, Calif.*	X-13 Vertijet	Mod. tail sitter	1	21'	24'	18				1 R-R Avon @ 10,000 lb. t.	N.A.	None			Operates from platform.
	VZ-3RY	Vectored slipstream	1	23' 8"	27' 8"	10' 8"			2,600	1 Lyc. T53 @ 850 shp.		2			
Sikorsky Aircraft Division United Aircraft Corp. *Stratford, Conn.*	S-57	Convertiplane Unloaded rotor	43							1 P&W JT-12 @ 3,000 lb. t.				570	Single-blade retracting rotor Projected 300 naut. mi. range
Spacetronics, Inc. *Washington, D.C.*		Ground effect	1							1 piston @ 12 hp.	48"	1	4-8"		Testbed built
Vanguard Aircraft Air & Marine Corp. *Paoli, Pa.*	Model 2	Ducted fan	2	22	24' 9"					1 Lyc. O540 @ 285 hp.					Testbed. Wing-buried rotor props. Now in test phase
Vertol Aircraft Corp. *Morton, Pa.*	VZ-2	Tilt wing	2	24' 11"	26' 5"	10'	110	2,800	3,500	1 Lyc. T53 @ 825 shp.	114"	2			Numerous conversions made

Military definition of VTOL aircraft is one which can clear a 50-ft. obstacle 50 ft. from start of takeoff. STOL aircraft is one which can clear a 50-ft. obstacle 500 ft. from start to takeoff. Many VTOL aircraft can also function as STOL types, carrying higher payloads in latter configuration. Army-Navy-Air Force VTOL and STOL projects embrace wide variety of propulsion and lift schemes. Most are test beds providing flight research data for future operational vehicles.

Abbreviations
- All — Allison
- AS — Armstrong-Siddeley (now Bristol Siddeley)
- Con — Continental
- GE — General Electric
- Lyc — Lycoming
- N.A. — Not applicable
- P&W — Pratt & Whitney Aircraft.
- Kiek. — Kiekhaefer
- RR — Rolls-Royce

¹ U. S. Army Flying Platforms, dimension given (span) is width of vehicle.
² Hovering ceiling in ground effect.

U.S. Civil and Military Rotary-Wing Aircraft

Manufacturer and Address	Model number	Designation	No. of crew	No. of passengers	Cargo capacity, lb.	Rotor diameter	Max. length, blades unfolded	Over-all height to top of rotor	Weight empty, lb.	Max. gross wt. lb.	No., make, model and max. rating	Max. speed, mph, at altitude, ft.	Hovering ceiling in ground effect, ft.	Normal still-air range, mi.	Remarks
Bell Helicopter Corp. *Ft. Worth, Texas*	47G-2	Trooper	1	2	555	35' 1"	41 5"	9' 8"	1,564	2,450	1 Lyc. VO435 @ 200 hp.	105 @ S.L.-4,000	10,850	238	Army H-13H
	H-13H	Sioux	1	2	583	35' 1"	41 5"	9' 4"	1,564	2,450	1 Lyc. VO-435 @ 200 hp.	105 @ S.L.-4,000	10,850	238	Army H-13J
	HTL-7		1	1	874	37' 2"	43 4"	9' 4"	1,610	2,565	1 Lyc. O435-6 @ 240 hp.	105 @ N.R.	6,200	154	Instrument trainer
	47H	Ballaros					41 3"	9' 4"	1,400	2,150	1 AM O-435-200-C32 @ 200 hp.	90 @ S.L.-4,400	4,200	211	Commercial only
	47G-3	Trooper	1	2	1,110	37' 2"			1,661	2,550	1 Frank. 6VS-335 @ 225 hp.		16		
	47J	Ranger	1	3	1,210	37' 2"	43 4"	9' 4"	1,615	2,565	1 Lyc. VO-435 @ 220 hp.	105 @ S.L.-7,000	7,400	222	Also 2,800 ...
	HU-1A	Iroquois	1	6-10	2,250	44	53	11' 3"	3,850	7,200	1 Lyc. T53-L-1 @ 770 hp.	142 @ N.R.	14,400	166	Former H-40
	XV-3	Conv't plane	1	3	1,200	23			3,600		1 P&W R985 @ 450 hp.				
	47J-2	Ranger								2,850	1 Lyc. VO-540 @ 305 hp.				
Benson Aircraft Corp. *Raleigh, N.C.*	B-8	Gyro-glider	1	1	360	20'	20'	5' 4"	100	472		60 @ S.L.			
	B-8W	Hydro-glider	1	1		20	20'	7' 4"	150	500		60			
	B-8B	Gyroboat	1	2		21'	21'	5' 6"	135	600		60			
	B-9	Little Zipster	1	2		22'	22'	11' 4"	385	900	1 Kiekhaefer Mk. 75 @ 70 hp.	90 @ S.L.	4,600	100	
Brantly Helicopter Corp. *Phil., Pa.*	B-2	YHO-3	1	1	50	23' 11"	27' 9"	6' 11"	980	1,600	1 Lyc. VO360-A1A @ 180 hp.	100 @ S.L.	4,000	300	All-metal
Cessna Aircraft Co. *Wichita, Kans.*	CH-1C	YH-41	1	1	100	35	32' 8"	8' 6"	2,045	3,000	1 Con. FSO470 @ 260 hp.	124 @ S.L.	9,800	260	Modified YH-41
Doman Helicopters, Inc. *Danbury, Conn.*	D-10		1	7	1,000	48'	48' 6"	10' 5"	3,445	5,500	1 Lyc. SO720	100 @ S.L.	4,800	310	
	LZ-5	YH-31	1	7	1,400	48'	48' 6"	10' 8"	3,287	5,200	1 Lyc. SO580-A1B @ 400 hp.	75 @ 1,000	4,000	350	
	D-12		2	5		30' 6"	26' 4"	7' 0"		1,450	1 All. 250-C1 @ 250 shp.	140 @ N.R.	23,500	290	Study
Gyrodyne Co. of America *St. James, N.Y.*	GCA-41A	YRON-1	1	0	60	17	17'	8'	480	725	1 Porsche YO 95-? @ 62 hp.	68 @ S.L.	4,800	56	
	GCA-41B	YRON-1	1	0	60	17	17	8'	325	725	1 Solar T-62 @ 80 hp.	72 @ S.L.	NA	31	
	GCA-50	XRON-1	1	0	60	20	20'	9'	538	919	1 Porsche YO-95-6 @ 72 hp.	77 @ S.L.	7,300	53	Marines rotorcycle
	DSN-1		0	0							1 Porsche GP 702 ?				Destroyer ASW drone.
Hiller Aircraft Corp. *Palo Alto, Calif.*		YROE-1	1	0	60	18' 6"	18' 6"	6' 11"	300	556	1 Nelson H63B @ 45 hp.	79 @ S.L.	5,300	50	Marines rotorcycle
		H-23D	1	2	407	35' 5"	40' 9"	9' 9"	1,816	2,700	1 Lyc. VO-435 @ 250 hp.	95 @ S.L.	5,200	200	1,000-hr. + transmission Army
	UH-12E	12E	1	2	578	35' 0"	40' 8"	9' 9"	1,?60	2,700	1 Lyc. VO-540 @ 305 hp.	91 @ S.L.	11,450	200	Commercial only
Hughes Aircraft Div. *Culver City, Calif.*	269A	YHO-2	1	1		25'	28'	8'	947	1,550	1 Lyc. O360-C2B @ 180 hp.	85 @ S.L.	13,800	220	45 min. engine change
Kaman Aircraft Corp. *Bloomfield, Conn.*	H-43A		2	3	2,400	47	47'	11' 10"	5,300	5,800	1 P&W R1340 @ 600 hp.	110 @ 4,000	14,000	220	Local base rescue.
	H-43B	Huskie	2	8	2,000	47	47	12' 6"	4,800	7,100	1 Lyc. T53 @ 860 shp	107 @ 6,800	20,000	350	World altitude record
	HU2K-1	Seasprite	2	4	4,000	44	52' 2"	12' 6"	[illegible]	[illegible]	1 GE T58-GE-6 @ 1,050 eshp.				Navy utility
	HOK-1		2	3	2,600	47	47'	12' 8"		6,100	1 P&W R1340 @ 600 hp.	100 @ 4,000	12,000	220	HUK-1 is Navy version
	HTK-1		0	0		41	41	12' 3"			1 Lyc. O435 @ 245 hp.				Robot development
	K-17		2	0		37	37	9' 9"	150	2,000	1 Turbomeca Turmo @ 400 eshp.	60 @ S.L.			Propulsion research
Kellett Aircraft Corp. *Willow Grove, Pa.*	KH-15		1	0							2 RMI rockets @ 16 lb. t.				Research vehicle
	KD-1A		1	1		40	40'	10' 9"	1,600	2,200	1 Jacobs L-4MA @ 225 hp.	115 @ N.R.	14,000	120	Autogiro.
	KD-1B		1	1		40	33	9' 11"	1,755	2,300	1 Con. 10520 @ 280 hp.	150 @ N.R.	21,000	420	Autogiro
McDonnell Aircraft Corp. *St. Louis, Mo.*	120		1	1		31	31	9'	2,000	5,000	3 AiResearch GTC-85-135 @ 65 hp	120 @ S.L.	10,500	84	Flying crane
Republic Aviation Corp. *Farmingdale, N.Y.*	Alouette		1	4	1,090	36' 6"	31' 10"	9'	1,830	3,000	1 Turbomeca Artouste II B @ 360 shp	105 @ 14,500	13,500	350	Sud Aviation license
Sikorsky Aircraft *Stratford, Conn.*	S-55A	H-19B&D	1-2	10	2,100	53'	62' 3"	13' 4"	5,250	7,500	Wr. R-1300-3 @ 800 hp.	112 @ S.L.	9,600	500	
	S-55C	H-19A&C	1-2	10	1,700	53	62' 3"	13' 4"	4,950	7,200	P&W R-1340-57 @ 600 hp.	101 @ S.L.	2,000	400	
	S-56	H-37A	2-3	23	6,000	72	88' 0"	17' 1"	20,000	31,000	P&W R-2800-54 @ 2,100 hp.	130 @ S.L.	7,000	145	
	S-58	H-34A	1-2	14	4,000	56	65' 10"	14' 4"	7,630	13,000	Wr. R-1820-84 @ 1,525 hp.	123 @ S.L.	4,900	182	
	S-60		2		8,000	72	87' 11"	17' 0"	18,913	31,000	P&W R-2800-54 @ 2,100 hp.	130 @ S.L.	6,500	205	
	S-61	HSS-2	4			62'	72' 5"	16' 4"	10,854	17,300	GE T-58-8 @ 1,250 hp.				
	S-61L		2-3	23	8,500	62'	72' 5"		10,750	18,700	GE CT-58-110-1 @ 1,250 hp.	150 @ S.L.	6,800	235	
	S-62		1-2	9	2,300	53	62' 3"	14' 2"	4,900	8,000	GE CT-58-100-1 @ 1,000 hp.	124 @ S.L.	13,500	200	
Vertol Aircraft Corp. *Morton, Pa.*	107	YHC-1	3	23		48' 4"	81' 8"	16' 10"	9,100	15,500	2 Lyc. T53 @ 820 shp	141 @ 400			Prototype
	107 II		2	25	5,836	50'	83' 4"			18,100	GE T58-8		7,800		
	105		2	20		44			8,?50	14,?00	? Lyc. T53 @ 825 shp.	149 @ S.L.			Turbine Testbed.
	44		2	15-19	5,420	44			8,190	11,300	1 Wr. R1820	115 @ N.R.	4,800		
		H-21A	1-2	14		44	86' 1"	15'	8,300	14,500	1 Wr. R1820-103 @ 1,150 hp.	149 @ S.L.	14,000	450	
	43	H-21B	1-2	20		44	86' 4"	15'	9,000	15,000	1 Wr. R1820-103 @ 1,425 hp.	140 @ S.L.	9,000	400	
	43	H-21C	1-2	20	1,500	44	86' 4"	15'	8,500	15,000	1 Wr. R1820-103 @ 1,150 hp.	140 @ S.L.	6,100	400	
		H-21D	2	20		44			8,511	14,700	2 GE T58 @ 1,024 shp.	145 @ S.L.			Turbine test
		YHC-1B	2	27-33	6,000		51'	18' 6"	16,400	23,500	2 Lyc. YT 55-L-5 @ 1,000 shp	170 @ S.L.	12,300		Chinook

- All — Allison
- AM — Aircooled Motors.
- Con. — Continental.
- GE — General Electric.
- Lyc. — Lycoming.
- N.R. — Not reported
- P&W — Pratt & Whitney Aircraft.
- RMI — Reaction Motors
- Wr. — Wright.

USSR Military and Civil Aircraft

Mission	Designation	NATO Code name	No. of crew	Over-all span, ft.	Over-all length, ft.	Gross weight, lb.	No. designation and max. power each engine	Maximum speed, mph	Service ceiling, ft	No. and type weapons	Remarks
FIRST-LINE AIRCRAFT											
STRATEGIC BOMBERS			—	79	100	000 000	2 x tj @ 35,000 lb.t. 2 x ramjet @ 70,000 lb t.				Nuclear bomber prototype credited to designer V. M. Myasishchev
	Type 37	Bison		170	140	350 000	4 x Lulka tj @ 18,000 lb. t.	618	57 000		Equipped for aerial refueling.
	Tu-20	Bear		120	150	330 000	4 x tp @ 12,000 eshp	550	50 000		Range about 8,000 mi
	Tu-16	Badger		100	100	150 000	2 x Lulka tj @ 18,000 lb.t.	600	50 000		Comparable to Boeing B-47
TACTICAL BOMBERS	Il-28	Beagle	3	68	60		2 x RD-45 tj @ 5,000 lb t.	600	45 000	2 x 23-mm. 2 x 12.7-mm.	Satellite production and use
	Il-30	Blowlamp	2	57	70		2 x tj @ 17,000 lb. t.	*50			35-deg. wing sweepback
	Tu-11	Bosun	3	70	65	60 000	2 x VK-1 tj @ 5,000 lb.t.	500			Navy torpedo bomber
		Backfin	3	75	85		2 x tj @ 17,000 lb.t.	600			Experimental prototype flew summer 1957. 35-deg. wing sweepback.
FIGHTERS	MiG-21	Faceplate	1	33	50		1 x axial tj @ 22,000 lb.t.	1,200	60 000		Operational.
	MiG-?	Fitter	1				1 x axial tj @ 22 000 lb.t	1,000			Competitor to MiG-21, not in production, used area rule
	MiG-19	Farmer	1			27 000	2 x axial tj @ 8,000 lb t.-aft.	900	66 000	2 x 23-mm.	Low-set slab tail. 3,000 in service.
	Su-15	Fishpot	1	25	50		1 x axial tj @ 22 000 lb t.	1 200	60 000		Delta. 54-ft tailpipe dia. all-weather, in production
	Su-10	Fishbed			—		—				Competition to Su-15, not in production
	Yak-25	Flashlight A	2	40			2 x axial tj @ 8,000 lb. t.	700		2 x 37 mm	Standard operational all weather fighter
	Yak-?	Flashlight B	2	40	55	30 000	2 x axial tj	600			Light bomber
	Yak-?	Flashlight C	2	41	55	30 000	2 x axial tj	600			All-weather, in production
	MiG-17	Fresco	1	33	37	15 000	1 x VK-2JA tj @ 5,650 lb t.	M>1	51 000	2 x 23-mm. 1 x 37-mm.	MiG-15 development. C & D models have aft. & radar fire control system for limited all-weather capability
	MiG-15	Fagot	1	33	36	11 265	1 x VK-2 tj @ 5,000 lb t.	653	51 000	2 x 23-mm. 1 x 37 mm.	Satellite production and use; minimum 15,000 built.
HELICOPTERS	Mi-1	Hare	4	47 6		4 938	1 x ASh-26B @ 575 hp	105			Range 400 mi.
	Mi-3		4	47	40	5 120		124			Mi-1T development.
	Mi-4	Hound	2	69		12 015	1 x ASh-82V @ 1,700 hp.	130	11 [illegible]	None	Aeroflot uses 16-place Mi-4P
	Mi-6	Hook				—	2 x Sol. @ 5,500 lb t.				New FAI 100 km. speed record 166.5 mph; has carried 24,000 lb payload to 7,500 ft alt
	Yak-24	Horse	4	69	70	35 000	2 x ASh-82V @ 1,430 hp			None	Yak-24K is plush seat civil executive transport for Aeroflot.
	Yak-24K	Flying-Bus			60	22 665	2 x ASh-82B @ 1 250 hp.	—		—	
	Ka-15	Hog					1 x 250 hp				Coaxial rotor 4 passenger
	Ka-10	Hat	1			440	1 x 55 hp.		8 000		Coaxial rotor
	Ka-18	Hen					1 x 225 hp.	90	11 000		Coaxial rotor 2 passenger
TRANSPORTS	An-2	Colt	2	54	38	11 000	1 x ASh-62IR @ 1 000 hp.	127	27 [illegible]	None	Holds FAI altitude record
	An-?	Camp				77 100	2 x NK tp @ 4 000 eshp			Tail turret	Assault transport. Aeroflot freighter
	An-10	Cat	3-5				4 x NK&AI tp @ 4,000 eshp.	450	30,000	None	85 passengers. An-10A carries 100
	An-16						4 x NK&AI tp @ 4,000 eshp.			None	130 passengers like An-16
	An-14	(Little Bee)		65	36	7 050	2 x AI-14R	143		None	Antonov design 6 passengers.
	Il-12	Coach	2-5	104	70	38 000	2 x ASh-82FNV @ 1,850hp.	232		None	USSR, Polish, Czech airlines 3,000 built.
	Il-14	Crate	2-3	104	70	00,000	2 x ASh-82T @ 1 900 hp	200	1 000	None	Il-12 development/replacement; prod 30 month.
	Il-14M	Crate			—					None	24-passenger version
	Il-18	Coot	3-5		—		4 x NK&AI tp @ 4 000 eshp.		30 000	None	75-100 passengers 2 600-mi range
	Tu-70	Cart	4	141	110		4 x ASh-82FNV @ 1 450 hp.	216		None	Tu-4 development (Boeing B-29 copy)
	Tu-100	Camel	5	114	121	150 182	2 x M-209 tj @ 14,880 lb t.	600	70,000	None	ICAO range 1,855 mi
	Tu-104A	Camel A	3					600		None	70 passengers. Tu-104B carries 100
	Tu-110	Cooker	5	122	125	142 152	4 x M-209 tj @ 15 000 lb t.	600	35 000	None	2,000-mi nonstop full-load range 80 passengers 1st class, 100 tourist.
	Tu-114	Cleat	4		177		4 x NK-12M tp @ 12,000 eshp	350	35,000	None	Moscow-N.Y. nonstop capability with 100 passengers
	Tu 114D	—	—	160 8	—	240 000	4 x NK 12M tp @ 12,000 eshp.				—
	Tu-124										New medium range transport
	Li-2	Cab	2	00	60		2 x M-62R @ 1 000 hp.				USSR-built Douglas DC-3
	Be-6	Madge		109		51 000	2 x ASh-73 @ 2,000 hp.	200	3 045		Patrol flying boat similar to Martin P5M-1
	Tu-104B			144	124 4		2 x AM-3	500		—	
SUPPORT AIRCRAFT											
BOMBERS	IL-10	Beast	2	45 5	40		1 x AM-42 @ 2 000 hp	300		1 x 12.7 mm 2 x 7.62 mm.	Satellite use
	Il-20	Butcher	3	66	60		2 x axial tj @ 5,000 lb t.	570	45 000	2 x 23-mm. 1 x 20-mm.	Production predecessor of Il-28.
	Tu-4	Bull	6-8	141	99		4 x ASh-82FNV @ 1 850 hp	225			Russian copy of Boeing B-29
	Tu-?	Barge		160	145	210 000	1 x tp @ 4 500 eshp.	380			Pre-production quantities turboprop testbed for Bear
	Tu-2	Bat	5	61 9	45 3	28 224	2 x ASh-82FNV @ 1 850 hp.	250	30 000	2 x 20-mm. 3 x 12.7 mm.	Polish and Red Chinese service
TRAINERS	Yak 18A		2				1 x radial piston	161	16 [illegible]		Tricycle gear
	Yak 18P		1				1 x radial piston	174	21 000		Tricycle gear

Abbreviations
AM—A. A. Mikulin
An—O. K. Antonov
ASh—A. D. Shvetsov
Il—Sergei Ilyushin
AI—A. G. Ivchenko
Ka—Nikolai Kamov
La—Semyon Lavochkin
[1]Rotor diameter
M—Motor (old designation)
MIG—Artem Mikoyan & Mikhail Gurevich
Mil—Mikhail Mil
NK—N. D. Kuznetsov
Sol—Soloviev
Su—Pavel Sukhoi
tj—turbojet engine
tp—turboprop engine
Tu—Andrei Tupolev
VK—V. Klimov
Yak—Aleksandr Yakovlev
a/b—afterburner

Foreign Rotary-Wing Aircraft

Manufacturer and Address	Model designation	Name	Seats incl. crew	Rotor diameter	Length blades folded	Max. height	Weight empty, lb.	Normal gross weight, lb.	Number, make, model and max. rating, ea.	Fuel capacity gal.	Maximum speed, mph	Initial rate of climb, fpm	Hovering ceiling in ground effect, ft	Service ceiling, ft.	Maximum still air range, mi.	Remarks
CZECHOSLOVAKIA Czechoslovak Aircraft Works *Prague*	HC-2	Heli-Baby	2	29' 10"	34' 4"	8' 4"	838	1 250	1 Praga DH @ 83 hp	5 8	84	708	3 040	9 040	13	In production in Otrokovice
FRANCE Sud Aviation *Paris*	S.E. 3130	Alouette II	5	33' 0"	31' 5"	9'	1 874	3 300	1 Turbomeca Artouste II @ 400 eshp	152	106	880	11 150	14 800	348	Republic licensee in U.S.
	S.O. 1221	Djinn	2	36	17' 5"	5' 7"	790	1 670	1 Turbomeca Palouste @ 325 eshp		82	895	3 280		210	Republic licensee in U.S.
	S.E. 3200	Frelon	20+	49' 2"	48' 10"	15' 5"	9 920	16 530	3 Turbomeca Turmo III @ 750-900							Prototype. First flight 6 10 59
	S.E. 3160	Alouette III	7	36' 1"	30' ½"	5' 5"	2 500	4 100	1 Turbomeca Artouste III @ 570 shp	187	124		13 000	13,000	155	
Helicop-Air *Paris*	L 50	Girhel	2	32					1 Con. C90 @ 90 hp.							
	L 51	Girhel	2						1 Lyc O-320 @ 150 hp.							
GREAT BRITAIN Bristol Aircraft, Ltd. *Filton*	171 Mk. 4	Sycamore	5	14' 1"	46' 2"	10' 1"	4 130	5 400	1 Alvis Leonides 521 1 @ 525 hp.	107	115	750	7 300		270	Military, civil models.
	192		27	48' 8"	80' 6"	17	10 553	18 000	2 Napier Gazelle 2 @ 1 650 shp	370	129	1 176	11 050	13 250	495	Tandem rotors.
Fairey Aviation, Ltd. *Hayes, Middlesex*		Rotodyne	56-70	104	104	2" 3"	36 504	53 000	2 RR Tyne @ 5 000 shp	1 250	201	2 000			738	Kaman is US licensee
		Rotodyne	90	90	90	22' 2"		38 000	2 Napier Eland N. EL. 5 @ 2 800 shp	1 250	185+	2 000			450	Prototype
Westland Aircraft, Ltd. *Yeovil, Somerset*	Mk 1	Whirlwind	12	53	41' 8½"	13' 3"	5 260	7 800	1 P&W R-1340-40 @ 600 hp	145	100	800		7 000	000	Many civil and military versions.
		Widgeon	5	49' 2"	40' 10"	13' 3"	4 474	5 900	1 Alvis Leonides 521 4 @ 300 hp.	90 2	104	700	5 000	10 000	310	Version of Dragonfly (Mk. 8-41)
(Ex-Saunders-Roe)	P 531 1	WASP	6	2" 3"	30' 4"	10' 4"	2 836	3 150	1 Blackburn Turmo 600 @ 425 shp	150	110	1 250	5 000		200	Main rotor 200 rpm
	P 531-2	WASP	6	22' 3"	30' 4"	10' 4"	2 836	3 600	1 Blackburn A-129 @ 565 shp.	100	128	1 400	17 000		232	Main rotor 400 rpm
	P 502	Skeeter Mk 12	2	32	28' 5"	10' 2"	1 656	2 250	1 DH Gipsy Major @ 215 hp	23	104	1 100	1 000	12 200	206	Main rotor 340 rpm
	103		1	22' 7"	18' 7"	8' 4"	870	970	1 Agusta MVG A 70 @ 80 hp.		90	710	7 300	12 000	280	Also versions of Bell 47G & J
Aer Lualdi *Rome*	L 59		4	34' 0"	26' 4½"	9' 8"	1 427	2 557	1 Con. IO-470-D @ 260 hp.	40	100	800	8 500	10 300		Series production
Fiat Aviation Division *Turin*	7002		7	30' 5"		9' 5"	1 520	3 085	1 Fiat 4700 gas generator @ 530 hp		100			11 150	183	Two-blade rotor
NETHERLANDS Nederlandse Helicopter Industrie N V *Papendrecht*	H-3	Kolibrie	2	33	33'	6	600	1 540	2 NHI TJ-5A ramjets @ 62 hp.	100	70	440	1 300	11 000	45	Agriculture
POLAND Aircraft Construction Center *Swidnik*	SM 2		5	4"	55' 7½"	10' 10"	4 900	5 390	1 AI-26V @ 575 hp		90	590	8 562	13 120	217	Redesigned SM-1 Polish version of Mil Mi-1
	BZ-4	Zuk	4	33' 4½"	41' 10"	8' 6½"	2 315	3 300	1 Narkiewicz WN-4 @ 320 hp.	44	97	905	1,970	8 846	164	
WEST GERMANY Carl F. W. Borgward *Bremen*		Kolibri I	3	30' 10"	27' 3"	10	1 700	2 645	1 Lyc. VO-435-A1B @ 260 hp.	40	100	700	492	14 750	280	Production follows 2nd prototype
Bolkow-Entwicklungen *Ottobrunn Bei Munchen*		Bo-103	1	21' 7"				882	1 ILO @ 40-50 hp.		87				280	Trainer

Leading Foreign Aircraft, Military and Civil

Manufacturer	Model designation	Name	Mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing area, sq. ft.	Weight empty, lb.	Gross weight, lb.	No., make, model, max rating of powerplants	Maximum speed, mph
ARGENTINA Fabrica Militar de Aviones (Instituto Aerotecnico) *Córdoba*	I.A. 35	Huanquero	Multi	3	8	61 1	45 10"	15 5	465	7 750	13 700	2 I.A. 19 R El Indio @ 600 hp.	275
	I.A. 37		Research	1	0	32' 9"	36	11 9	516	6 100	9 900	1 R.R. Derwent 5 @ 3 600 lb. t.	500
	I.A. 38		Cargo/Transport			105'	44 3"	15	1 431	18 700	35 200	4 I.A. 16 El Gaucho @ 450 hp.	150 5
	I.A. 45		Personal	1	3 4	41 0"	29	8 2"	205	2 425	3 370	2 Lyc. O-320 @ 150 hp	178
	I.A. 46		Utility	1	2	33 7"	24 11"	7 3"	194	1 213	2 201	1 Lyc. O-320 @ 150 hp	121
AUSTRALIA Commonwealth Aircraft Corp. Pty. Ltd. *Lorimer Street, Port Melbourne, Victoria*	C.A. 25	Winjeel	Trainer	3	0	38 9"	28	5	246	3 2[illegible]	4 [illegible]35	1 P&W R985-AN[illegible] @ 450 hp.	18[illegible]
	C.A. 27	Sabre Mk. 32	Fighter	1	0	37 1"	37 6"	14 5"	302	11 000	20 000	1 R.R. Avon 26 @ 7,500 lb. t.	700
	C.A. 28	Ceres	Agricultural	1	0	47	30 3"	5'	312	4 660	[illegible] 000	1 P&W Wasp S3H1-G @ 600 hp	140
Government Aircraft Factories *Fishermans Bend, Melbourne, Victoria*		Canberra 20	Bomber	2	0	64	65 6"	15' 3"	960		51 000	2 R.R. Avon Mk. 109	
		Jindivik Mk. 2	Drone	0	0	19	23 4"		76	1 750	2 800	1 B-S Viper ASV3	5[illegible]0
BELGIUM Avions Fairey S.A. *Gosselies*		Tipsy Junior Mk. VI	Sport, Training	1	0	23	15' 9½"	4 6"	113	470	770	1 Lim. @ 65 hp.	107
	T66 Mk. 2	Tipsy Nipper	Sport, Training	1	0	19 8"	15	6 5"	87' 6"	420	680	1 Hagenfeldon Stark KG "Stamo" 1100A @ 45 hp.	73
BRAZIL Sociedade Construtora Aeronautica Neiva, Ltda *Rua [illegible] Fabrica, 800 Botucatu, Sao Paulo*	IPD5802		Reconnaissance	1	1	65 3"	23	5	180	1 100	2 400	1 Lyc. O-320 @ 150 bhp	
	P-56-1	Paulistinha	Primary Trainer	1	1	35 5	22'	6 2"	150	680	1 300	1 Cont. C-90-8F @ 95 bhp	128
CANADA Avro Aircraft Ltd. *Box 4004, Terminal "A", Toronto, Ontario*	CF-100 Mk. 5		Interceptor	2	0	60 10"	51 [illegible]"	14 6"	591		33 800	2 Orenda 11 @ 7 000 lb. t.	
Canadair Ltd. *P.O. Box 6087 Montreal, Quebec*	CL-13	Sabre 6	Fighter	1	0	37 1½"	37 6"	14 5"	288	10 540	15 100	1 Orenda 14 @ 7,200 lb. t.	700
	CL-28	CP 107 Argus	Anti-sub.	15	0	142 4"	128 3"	38 8"	2 075	81 000	148 000	4 Wright R-3350 @ 3 700 hp.	288
	CL-30	Silver Star	Trainer	2	0	42 5"	37 8"	11 8"	238	8 140	10 800	1 R.R. Nene 10 @ 5 100 lb. t.	530
	CL-41		Trainer	2	0	36 1"	32 0	9 4½"	220	4 700	5 500	1 P&W JT12 @ 2 400 lb. t.	4[illegible]4
	CL-44-6	CC 106	Transport	5	131	142 1"	136 7"	38 8"	2 075	88 520	205 000	4 R-R Tyne 12 @ 5 730 ehp.	406
	CL-44D-4	Forty Four	Cargo	4	0	142 4"	136 7"	38 8"	2 075	87 875	205 000	4 R-R Tyne 12 @ 5,730 ehp.	405
	CL-44D-4	Forty Four	Transport	4	160	142 4"	136 7"	38 8	2 075	90 930	205 000	4 R-R Tyne 12 @ 5730 ehp.	388
	CL-66B	CC-109	Transport	3	40	105 1"	81 6"	28 1½"	920	35 187	57 500	2 Napier Eland 504A @ 3 500 ehp.	335
	CL-90	CF 104	Strike reconn.	1	0	21 11"	54 9"	13 6"	180			1 GE J79-GE-7 @ 15,500 lb. t.	M2+
	CF 104		Strike recon.	1	0	21 11"	54 5	13 6"	180			1 GE J79-7 @ 15 800 lb. t.	M2+
The de Havilland Aircraft of Canada, Ltd. *[illegible] P.O. Ont.*	DHC-2	Beaver	Transport	1-2	5	48	30 4"	10 7"	250	2 001	5 100	1 P&W @ 450 hp	163
	DHC-3	Otter	Transport	1-2	5 10	58	42	18	375	4 358	8 000	1 P&W @ 600 hp.	153
	DHC-4	Caribou	Transport	2	30	95	68	25	920	11 000	26 000	2 P&W @ 1 450 hp	214
EAST GERMANY Vereinigung Volkseigener Betriebe Flugzeugbau *[illegible]*	Baade B.B.152		Transport	4 5	48-72	86 8"	102 8"	31 10"	1 485	63 600	102 515	4 Type 014 @ 6 645 lb. t.	572
	IL-14P		Transport	3 4	26	104	69 11"	26 11"	1 075	28 600	37 500	2 Ash-82T @ 1 900 hp.	237
FRANCE Societe Boisavia *11 Rue [illegible]*	B 606	Mercurey	Personal	1	3	37 6	23 0"	7 6"	194	1 430	2 375	1 SNECMA 4LO2 @ 170 hp	155
S.A. des Ateliers d'Aviation Louis Breguet *24 Rue Georges Bizet, Paris XVI*	1050	Alizé	Carrier Based ASW	3	0	51 2"	45 5"	16 1"	377	12 500	18 100	1 R-R Dart 21 @ 1550 ehp	285
	763	Deux Ponts "Provence"	Civil Transport	3	107	140 8"	94 11"	31 1"	1 985	68 150	113 500	4 P&W R2800 CA 18 @ 2400 hp.	272
	765	Deux Ponts "Sahara"	Mil. Transport	4	135	140 8	94 11"	31 4"	1 985	68 343	119 000	4 P&W R2800 CB 16 @ 2400 hp.	265
	1150	Atlantic	ASW	12		119	89	30	1 292		86 000	2 R.R. Tyne	
	940	Integral	STOL Experimental	2	0	57 5"	39 1"		470		15 800	4 Turbomeca Turmo II @ 400 hp	236
	941		STOL Transport	2	0	75	71	29	890	23 000	41 000	4 GE T58 @ 1250 hp.	285
Generale Aeronautique Marcel Dassault *46 Quai Carnot, Saint Cloud (Seine-et-Oise)*	SMB-2	Super Mystere	Fighter Bomber	1	0	34 5"	46 1"	18 11"	376	15 400	22 050	1 SNECMA Atar 101-G @ 9,900 lb. s. t.	M 1>
		Etendard IV M	Fighter (Naval)	1	0	31 6"	46 3"	11	312		19 100	1 SNECMA Atar-8 @ 9700 lb. s. t.	M 1.06
		Mirage III	Fighter	1	0	27	45 5"	11 0"	366	12 350	18 740	1 SNECMA Atar-9 + 1 sepr. engine @ 13,225 lb	M 2>
		Mirage III-B	Fighter Trainer	2	0						18 450	1 SNECMA Atar 9 + sepr engine @ 13,225 lb	M 2>
		Mirage IV	Bomber	2	0						65 100	2 SNECMA Atar 9 @ 13,225 lb	M 2>
	MD-415	Communaute	Transport	2	8	53 11	42 8"	14 1"	28[illegible]	7 900	13 000	2 Turbomeca Bastan @ 750 hp	33[illegible]

* Cruise Speed   †—Approximately

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Maximum speed, mph.
Hurel-Dubois *Route de Versailles, Meudon Villacoublay (Seine-et-Oise)*	H.D. 321		Transport	5	40	148' 7½"	77' 4"	28' 7½"	1,076	24,458	41,200	2 Wright 982C9HE1 @ 1,525 hp.	260
	H.D. 34		Photo	7	0	148' 7½"	77' 8"	28' 7½"	1,076	26,300	42,000	2 Wright 982C9HE2 @ 1,475 hp.	260
Société des Avions Max Holste *11 Rue Carnot, Reims*	MH 1521	Broussard	Utility aircraft	1	5-7	45' 1"	28' 3"	12'	273' 4"	3,417	5,953	1 P&W R-985 @ 444 bhp.	165
	MH 250	Super Broussard	Light transport	1-2	20-23	71' 11"	57' 8"	21' 7"	593' 4"	11,168	21,493	2 "Bastan III" Turbomeca @ 585 eshp.	232
Morane-Saulnier *3 & Rue Volta, Puteaux (Seine)*	MS 733	Alcyon	Trainer	2	0	37'	31' 1"	11' 4"	215	2,810	3,960	1 Potez 6 D02A @ 240 hp.	164
	MS 760	Paris	Business	1	3	33' 3"	32' 11"	8' 7"	194	4,400	7,650	2 Turb. Marboré II @ 880 lb. t.	405
	MS 1500	Épervier	Attack	2	0	42	34' 8"	10' 6"	250	3,950	5,270	1 Turb. Bastan @ 570 eshp.	250
	MS 880	Rallye	Personal	1	2	28' 8"	20' 5"	6' 0"	112	930	1,570	1 Cont. C14F @ 85 hp.	118
Nord Aviation Société Nationale de Constructions Aéronautiques *1 bis Avenue Bosquet, Paris (7)*	Nord 2502	Noratlas	Transport	3	40	110' 3"	72		1,090	28,085	60,700	2 Bristol Hercules 758/790 @ 2,040 bhp + 2 Turbomeca "Marboré II" @ 880 lb. t.	
	Nord 2506	Noratlas	Transport	3	40	110' 3"	72		1,080	30,030	60,700	2 P&W R2800 @ 2,500 bhp. +2 Turbomeca "Marboré II" @ 880 lb. t.	310
	Nord 2501	Noratlas	Transport	3	42	107'	73	19' 1"	1,093	28,600	48,400	2 SNECMA Hercules @ 2,040 hp.	270
	Nord 3202		Trainer	2	0	30' 11½"	26' 2½"	10' 2"	177.6	1,813	2,415	1 Potez 4 D-32 @ 240 hp.	161
	Nord 1405	Gerfaut II	Fighter	1	0	24' 7"	32' 6"	13' 0"	282	8,098	12,232	1 SNECMA Atar 101G @ 9,700 lb. t.	M1.3
	Nord 1500	Griffon II	Interceptor	1	0	26' 7"	47' 8½"	10' 6"	341.6		11,650	1 SNECMA Atar 101E3 + 1 Nord ramjet	630
	Nord 3400		Liaison	1	1	41' 8"	27' 8"	10' 2"	208.6	2,028	2,676	1 Potez 4 D 30 @ 240 hp.	124?
Potez Air-Fouga *93 Rue Miromesnil, Paris (8)*	C.M. 170	Magister	Trainer	2		37	33	9'	186	4,248	6,570	2 Potez Air Fouga Type C.M. 170 @ 880 lb. t.	435
	C.M. 175	Zephyr	Carrier Trainer	2		37	33' 7"	9	186	4,766	7,417	2 Potez Air Fouga Type C.M. 170 @ 880 lb. t.	403
	Potez 75		Attack	2	0	43	30	8' 10"		3,891	[illegible]	1 Potez 8 D 32 @ 450 hp.	[illegible]
	P. 840		Transport		16-24	53	50			9,010	16,720	4 Turbomeca Astazou	300
SNECMA *150 Boulevard Haussmann, Paris (8)*	C 450	Coléoptère	VTOL	1	0		23' 3"				6,000	1 SNECMA Atar 101 E.8V @ 7,700 lb. t.	500
Sud Aviation *37 Boulevard de Montmorency, Paris (XVIe)*	S.E. 210	Caravelle	Transport	3-4	80	112' 6"	104' 10"	28' 6"	1,579	51,170	90,210	2 R-R Avon Mk. 527 @ 11,700 lb. t.	510
	S.E. 117	Voltigeur	Tac. Support	3	0	58' 11"	40' 3"	18' 7"	448	9,260	14,374	2 Turb. Bastan @ 780 shp.	248
	S.E. 118	Diplomate	Business	2	8-20	58' 11"	41' 3½"	20' 2"	450.5	9,523	16,347	2 Turb. Bastan @ 780 shp.	320
GREAT BRITAIN													
Sir W. G. Armstrong Whitworth Aircraft Ltd. *Baginton, Nr. Coventry, Warwickshire*	AW 650	Argosy	Freighter-coach	2-3	80	115'	86' 9"	27'	1,458	45,350	82,000	4 R-R Dart @ 2,100 eshp.	296
	AW 660	Argosy	Transport	4	77	115	86' 9"	27'	1,458	50,900	82,000	4 R-R Dart @ 2,100 eshp.	295
	AW 670	Air Ferry	Pass. Cargo	2-3	125	115'	86' 9"	27'	1,458	47,000	88,000	4 R-R Dart @ 2,100 eshp.	303
	AW 671	Air bus	Pass. Freight Trans.	2-3	88	115	86' 9"	27'		46,600	88,000	4 R-R Dart Mk. 526 @ 2,210 hp.	309
	F.(G.A.) Mk.6	Sea Hawk	Fighter Bomber	1	0	39	39' 8"	8' 8"	278	13,200	16,200	1 R-R Nene 103	524
Auster Aircraft, Ltd. *Rearsby, Leicester*	Mk. 9		Liaison	2	0	36' 6"	23' 8"	8' 11"	197.5	1,500	2,135	1 Bl. Bombardier @ 180 hp.	127
	B 8	Agricola	Agricultural	1	2	42	28' 1"	8' 4"	251.7		3,810	1 Cont. O-470-M @ 240 hp.	127
	J/1U	Workmaster	Agricultural	1	1	36	23' 7"	6' 2"	185		2,550	1 Lyc. O-360-A @ 180 hp.	104
		Atlantic	Business	1	3							1 Cont. IO-470 @ 260 hp.	135
	J1N	Alpha	Utility	1	2							1 DH Gipsy Major 1 @ 130 hp.	105?
	J5F	Aiglet	Trainer	2	1	32'	23' 2½"	8' 8"	184	1,323	2,200	1 DH Gipsy Major 1 @ 130 hp.	127
	J5B	Autocar	Personal	1	3	36	23' 2"	7' 0"	185	1,413	2,400	1 DH Gipsy Major 1 @ 130 hp.	116
		Alpine	Personal	1	2	36'	23' 2"	7' 8"	180			1 DH Gipsy Major 10 @ 145 hp.	124
Blackburn and General Aircraft Ltd *Brough, Yorkshire*	C. Mk. 1	Beverley	Transport	4	97	162	99' 5"	38' 9"	2,916	82,100	143,000	4 Bristol Centaurus @ 2,850	238
	N.A. 39		Strike	2		42' 6"	63' 4"	16' 0"				2 DeHavilland Gyron Junior	
Bristol Aircraft, Ltd *Filton House, Bristol*	175	Britannia 100	Transport	9	92	142' 4"	114	37' 6"	2,075	86,000	155,000	4 B-S Proteus 705 @ 3,900 eshp.	370
	175	Britannia 300	Transport	9	133	142' 4"	124' 3"	37' 6"	2,075	92,850	160,000	4 B-S Proteus 755 @ 4,120 eshp.	400
	175	Britannia 310	Transport	9	133	142' 4"	124' 3"	37' 6"	2,075	93,400	185,000	4 B-S Proteus 765 @ 4,445 eshp.	410
	175	Britannia 250	Pass./Cargo	9	81	142' 4"	124' 3"	37' 6"	2,075	85,900	185,000	4 B-S Proteus 765 @ 4,445 eshp.	410
	175	Britannia 320	Transport	9	139	142' 4"	124' 3"	37' 6"	2,075	94,500	185,000	4 B-S Proteus 765 @ 4,445 eshp.	410
The de Havilland Aircraft Co. Ltd *Hatfield Aerodrome, Herts*	D.H. 110	Sea Vixen	AW Fighter	2	0	50	53' 6½"	11'				2 R-R Avon	M>1
	D.H. 104	Dove	Transport	2	8-11	57	39' 4"	13' 4"	335	5,678	8,800	2 DH Gipsy Queen 70 Mk. 2 @ 380 hp.	200
	D.H. 114	Heron	Transport	2	14-17	71' 6"	48' 6"	15' 7"	499	8,484	13,000	4 DH Gipsy Queen 30 Mk. 2 @ 250 hp.	181
	D.H. 106	Comet 4	Transport	5	60-81	115	111' 6"	29' 6"	2,121	72,500	162,000	4 R-R Avon @ 10,500 lb. t.	515?
	D.H. 106	Comet 4B	Transport	4	72-102	108	118	29' 6"	2,059	75,120	158,000	4 R-R Avon 29 @ 10,500 lb. t.	530?
	D.H. 106	Comet 4C	Transport	4	72-102	115	118	29' 6"	2,121	75,500	162,000	4 R-R Avon 29 @ 10,500 lb. t.	500?
	D.H. 121		Transport	3	70-100	89' 10"	114' 9"	27	1,358	62,500	105,000	3 R-R RB163 @ 10,000 lb. t.	600+
	D.H. 112	Sea Venom Mk. 22	AW Fighter	2	0	42' 10"	38' 5"	8' 6"			15,800		575
The English Electric Co., Ltd. *Marconi House, Strand, London W.C.2*	P. 1B	Lightning F.1	AW Fighter	1	0	34' 10"	50	19' 5"				2 R-R Avon w/reheat	M>2
	P. 11	Lightning T.4	Trainer	2	0	34' 10"	50	19' 5"				2 R-R Avon w/reheat	M>2
	B. 6	Canberra	Bomber	2	0	64	65' 6"	15' 7"	960			2 R-R Avon	
	P.R. 7	Canberra	Photo Recon.	2	0	64	65' 6"	15' 7"	960		[illegible]	2 R-R Avon	M .68?
	B(I)8	Canberra	Bomber	2	0	64	65' 6"	15' 7"	960			2 R-R Avon	
	P.R. 9	Canberra	Photo Recon.	2	0	68	66' 8"	15' 7"	990			2 R-R Avon	
	TSR 11		Strike									B-S Olympus	

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Maximum speed, mph.
Fairey Aviation, Ltd *Hayes, Middlesex*		Gannet AEW Mk. 3	Early Warning	3	0	54'	44'	16' 10"				1 B-S Double Mamba @ 3,875 eshp.	
		Gannet AS Mk. 4	Anti-sub	3	0	54' 4"	44'	13'	482.8	15,069	21,000	1 B-S Double Mamba @ 3,035 eshp.	316
		Gannet T Mk. 5	Trainer	3	0	54' 4"	43	13'				1 B-S Double Mamba @ 3,035 eshp.	
		Delta 2	Research	1	0	26' 9"	51' 8"	11	360			1 R-R Avon	M>1
Folland Aircraft Ltd *Hamble, Southampton, Hampshire*	FO 141	Gnat Mk. 1	Fighter	1		22' 2"	29' 9"	8' 10"	137	4,300	8,750	1 B-S Orpheus 701 @ 4,520 lb. t.	M .98
	FO 144	Gnat Trainer	Trainer	2		24	30' 9"	9' 7½"	175	[illegible]	7,135	1 B-S Orpheus @ 4,230 lb. t.	M>.9?
Gloster Aircraft Co. Ltd. *Gloucester*	T. 3	Javelin	Trainer	2	0	52	59	16	930			2 B-S Sapphire @ 8,300 lb. t.	
	FAW 7	Javelin	A.W. Fighter	2	0	52	56' 4"	16'	930			2 B-S Sapphire 7R @ 11,000 lb. t.	
	FAW 8	Javelin	A.W. Fighter	2	0	52	56' 1"		930			2 B-S Sapphire 7R @ 11,000 lb. t.	
	FAW 9	Javelin	A.W. Fighter	2	0	52	56' 4"		930			2 B-S Sapphire 7R @ 11,000 lb. t.	
Handley Page, Ltd *Claremont Road, Cricklewood, London N.W.2*	H.P. 80	Victor B Mk. 1	Bomber	5	0	110	114' 11"	28' 1½"				4 B-S Sapphire @ 11,000 lb. t.	
	H.P. 80	Victor B Mk. 2	Bomber	5	0	120	114' 11"	28' 1½"				4 R-R Conway @ 17,250 lb. t.	
	H.P.R. 7	Dart Herald	Transport	2	47	94' 9½"	71' 11"	23' 4"	886	22,805	39,000	2 R-R Dart @ 2,100 eshp.	265
	H.P. 115		Transport	[illegible]	8-12	71' 3"	51' 6"	17'	755		[illegible]	2 B-S Orpheus @ 3,950 lb. t.	530?
Hawker Aircraft, Ltd *Richmond Road, Kingston-on-Thames, Surrey*	P. 1121		Strike	1	0							1 DH Gyron	M>1
	P. 1067	Hunter F. 4	Fighter	1	0	33' 8"	45' 10½"	13' 2"	340			1 R-R Avon RA21 @ 8,000 lb. t.	
	P1067	Hunter F. 6	Fighter	1	0	33' 8"	45' 10½"	13' 2"	340			1 R-R Avon RA28 @ 10,000 lb. t.	
	P1101	Hunter T. 7	Trainer	2	0	33' 8"	48' 10½"	13' 2"	340			1 R-R Avon RA21 or RA28	
		Hunter T. Mk. 66	Trainer	2	0	33' 8"	49	13' 2"	340			1 R-R Avon Mk. 203 RA28	
Hunting Aircraft, Ltd *Luton Airport, Luton, Bedfordshire*		President	Transport	2	12	64' 6"	46	16	400	9,020	13,500	2 Al. Leonides @ 550 hp.	223
	P. 66	Pembroke	Multi	2	10	64' 6"	46	16	400	9,178	13,500	2 Al. Leonides @ 550 hp.	223
	P. 56	Provost T. Mk. 1	Trainer	2	0	35' 2"	28' 8"	12' 2"	214	3,350	4,400	1 Al. Leonides @ 550 hp.	200
	P. 84	Jet Provost T. Mk. 3	Trainer	2	0	35' 10"	[illegible]	10' 2"	214		[illegible]	1 B-S Viper @ 1,750 lb. t.	[illegible]
Lancashire Aircraft Co. Ltd [illegible]	EP 9	Prospector	Multi	1-2	2-4	43' 6"	30'	10	[illegible]	[illegible]	[illegible]	1 Lyc. GSO-480-B1A6 @ 295 hp.	146
F. G. Miles Ltd *Shoreham Airport, Sussex*	M. 100	Student	Trainer	1	1	29' 2"	31' 6"	6' 3"	114	2,400	3,900	1 Turb. Marboré II @ 882 lb. t.	[illegible]
	M. 100/2	Centurion II	Personal	1	3-4	29' 6"	31' 9"	7' 4"	162	3,882	7,000	1 B-S Viper @ 1,640 lb. t. or [illegible] @ 1,050 eshp.	419
A. V. Roe & Co. Ltd *Greengate, Middleton, Manchester*	698	Avro Vulcan B Mk. 2	Bomber	5	0	111	97' 1"	27' 2"				4 B-S Olympus 201 @ 17,000 lb. t.	
	696	Avro Shackleton Mk. 3	Anti-Sub	10	0	119' 10"	92' 1"	23' 4"	1,421		100,000	4 R-R Griffon 57A @ 2,455 hp.	300
	748 Series 1		Transport	3	40-44	95	67	24' 10"	795	[illegible]	33,000	2 R-R Dart R.Da.6 Mk. 514 @ 1,740 eshp.	294
	748 Series 2		Transport	3	40-44	95	67	24' 10"	795	18,694	38,000	2 R-R Dart R.Da.7 Mk. 531 @ 2,105 eshp.	310
Scottish Aviation Ltd *Prestwick Airport, Ayrshire*	CC Mk. 1	Prestwick Pioneer	Transport	1	4	49' 4"	35' 9"	10' 1"	390	4,200	5,800	1 Al. Leonides 530/7 @ 540 bhp.	145
	CC Mk. 1	Twin Pioneer	Transport	2	16	76' 6"	45' 3"	12' 3"	670	10,178	14,600	2 Al. Leonides 531/8 @ 635 bhp.	173
Short Brothers & Harland, Ltd *P.O. Box 241, Queen's Island, Belfast*	S.C. 5	Britannic	Strategic Freighter	4	[illegible]	158' 9"	136' 5"	47'	[illegible]	[illegible]	218,000	4 R-R Tyne R.Ty.12 @ 5,730 eshp.	361
	S.C. 7		Light Freighter	1-2	15	61' 1"	38' 11"	13' 11"	373	[illegible]	[illegible]	2 [illegible] @ 290 hp.	200
	S.B. 5		Research	1	0	[illegible]	45' 6"	[illegible]				Bristol Orpheus	
	S.C. 1		VTOL	1	0	23' 6"	[illegible]	[illegible]				5 R-R RB108	
Vickers-Armstrongs Aircraft Ltd *Weybridge, Surrey*	700	Viscount	Transport	2-3	40-63	93' 8½"	81' 10"	26' 9"	963	38,000	64,500	4 R-R Dart R.Da.3 Mk. 506 @ 1,540 eshp.	325
	700D	Viscount	Transport	2-3	40-63	93' 8"	81' 10"	26' 9"	963	[illegible]	64,500	4 R-R Dart R.Da.6 Mk. 510 @ 1,740 eshp.	341
	800	Viscount	Transport	2-3	[illegible]	93' 8"	85' 8"	26' 9"	963	[illegible]	64,500	4 R-R Dart R.Da.6 Mk. 510 @ 1,740 eshp.	341
	810	Viscount	Transport	2-3	[illegible]	93' 8"	85' 8"	26' 9"	963	41,565	72,500	4 R-R Dart R.Da.7/1 Mk. 525 @ 1,990 eshp.	370
	950	Vanguard	Transport	2-3	76-139	118	122' 10"	34' 11"	1,529	[illegible]	141,000	4 R-R Tyne R.Ty.11 Mk. 512 @ 5,525 eshp.	445
	1100	V.C. 10	Transport	2-5	[illegible]	140'	158' 10"	39' 1"	[illegible]	[illegible]	299,000	4 R-R Conway R.Co.42 Mk. 540 @ 20,250 lb. t.	600
		Scimitar F. Mk. 1	Fighter	1	0	37' 2"	55' 4"	15'				2 R-R Avon 200 series @ 11,250 lb. t.	
	674	Valiant B. Mk. 1	Bomber	5	0	114' 4"	108' 3"	32' 2"	2,362			4 R-R Avon RA.28 Mk. 204 @ 10,000 lb. t.	
		Swift F.R. Mk. 5	Fighter Recon.	1	0	32' 4"	41' 5½"	13' 6"	[illegible]		21,400	1 R-R Avon RA.7R Mk. 114 @ 9,450 lb. t.	[illegible]
	TSR. 2		Strike Recon.									B-S Olympus	
ITALY													
Industrie Meccaniche Aeronautiche Meridionali-AERFER [illegible], *Naples*		A.S. Sagittario II	Fighter	1	0	[illegible]	31' 2"	[illegible]	[illegible]	[illegible]	7,160	1 R-R Derwent 9 @ 3,600 lb. t.	[illegible]
		Ariete	Fighter	1	0	[illegible]	31' 4"			[illegible]		1 R-R Derwent + 1 R-R Soar	[illegible]
Costruzioni Aeronautiche Giovanni Agusta *Cascina Costa, Gallarate*	AZ-8L		Transport	2	[illegible]	[illegible]	63' 9"	21' 5"	715		23,810	4 Al. Leonides Mk. [illegible] @ 480 hp.	[illegible]
	[illegible]		Transport	2	32	[illegible]	63' 9"	21' 8"	719		23,810	4 SNECMA [illegible]	

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Maximum speed, mph.
Fiat-Divisione Aviazione *Corso G. Agnelli 200 Turin*	G 91		Fighter	1	0	28' 1"	31' 2 3/4"	13' 1"	188.7		11 350	1 B-S Orpheus B. Or 80 302 @ 4 850 lb. t.	M >1
	G 91T		Trainer	2	0	28' 2"	39' 3"	13' 9"	178.7	7 100	11 775	1 B-S Orpheus B. Or 80 302 @ 5 000 lb. t.	640
	G 91R		Photo Recon	1	0	28' 1"	34' 2 1/4"	13' 1"	176.7			1 B-S Orpheus B. Or 80 302 @ 5 000 lb. t.	M >1
	F 86K		Fighter	1	0	37' 2"	40' 1"	15'	288		18 000	1 GE J47-GE-17B @ 7 350 lb. t.	650
Aeronautica Macchi *Corso Vittorio Emanuele 11 Milan*	MB 326		Trainer	2	0	32' 11"	34' 0"	11' 1"	204.5	4 290	8 353	1 B-S Viper 11 @ 1 750 lb. t.	460
METEOR-Costruzioni Aeronautiche *Trento*	FL 53BM	Meteor Trio	Personal	1	2	31' 1"	22'	8' 1"	155	950	1 343	1 Meteor C90 CA @ 90 hp	120
	FL 55BM	Meteor Super	Personal	1	3	31' 1"	22' 4"	8' 1"	155	1 146	1 984	1 Meteor C190 CA @ 150 hp	110
Nardi S.A. per Costruzioni Aeronautiche *Aeroporto Forlanini, Milan*	FN-333	Riviera	Personal	1	3	34'	31'	10'	161.5	2 095	2 978	1 Con. O-470-H @ 240 hp.	160
Partenavia Costruzioni Aeronautiche *Aeroporto Forlanini Milan*	P-57-2	Fachiro II	Personal	2	2	30'	22'	8'	144.9	1 357	2 315	1 Lyc O-360-A2A @ 180 hp.	140
	P-59	Fachiro II	Personal & Trainer	2	2	30'	21' 7"	7'	144.6	1 000	1 570	1 Con. C90-12F @ 95 hp.	122
Piaggio & C., Societa per Azioni *Via Antonio Cecchi 6 Genoa (434)*	P 136-L1		Personal	1	4	44' 5"	35' 5"	12' 7"	270	4 120	6 000	2 Lyc GO-480-B1A6 @ 270 hp	154
	P 136-L2		Personal	1	1	44' 5"	35' 5"	12' 7"	270	4 680	6 518	2 Lyc GSO-480-B1C6 @ 340 hp	213
	P 149-D		Personal	1	1	36' 6"	28' 11"	9' 6"	203	2 557	3 701	1 Lyc GO-480-B1Ah @ 270 hp	192
	P 166		Personal	1	7	46' 9"	38' 1"	15' 5"	286	5 070	8 115	2 Lyc GSO-480-B1C6 @ 340 hp	220
	P 155-CT		Amphibian	4	30	102' 0"	64' 5"	31' 10"	1 076	32 000	53 500	2 Allison 501 D10 @ 3,750 eshp	350
Progetti Costruzioni Aeronautiche *Strada 4 V. Passo 18 Milano (Procaer)*		Cobra 400	Touring	1	1	26' 6"	22' 7"	5' 2"	131.5	1 790	3 055	1 Turbomeca Marbore II @ 880 lb. t.	360
		Picchio F 15	Personal	1	2-3	30' 7"	24'	6' 2 1/2"	119.4	1 315	2 205	1 Lyc. O-320-B @ 160 hp.	188
Aviamilano Costruzioni Aeronautiche *Via Marcantonio Melloni 76 Milan*	F 14	Nibbio	Executive	2	2	31' 5"	23' 7"	8' 1"	128	1 500	2 500	1 Lyc. O-360 A1A @ 180 hp.	205
	P 19	Scricciolo	Club Trainer	2		33' 6"	23'	8' 7"	150	880	1 540	1 Aguzzi M.V.G.A. 7010 85 hp.	160
	F 8	Falco		2		26' 3"	21' 3"	8'	107.6	1 133	1 715	1 Lyc. O-320 A1A @ 150 hp.	208
JAPAN **Nihon Aeroplane Mfg. Co., Ltd.** *Shiba Tamuracho Minato-Ku Tokyo*	YS-11		Pass. Trans.	3	52-60	105'	87' 3"	30' 7"	1 020	28 128	50 250	2 R-R Dart R.Da. 10 1x2 @ 2 660 eshp	
Fuji Heavy Industries, Ltd. *Marunouchi Chiyoda-Ku Tokyo*	T1 A	T1F2	Trainer	2		35' 7"	39' 7"	13' 3"	239	5 065	10 750	1 Orpheus Mk. 805 @ 4 000 lb. t.	
	T-34A	B-45 Mentor	Trainer	2		32' 9"	25' 9"	9' 8"	178	2 246	2 950	1 Continental O-470-13 @ 225 hp.	
	KM	Super-Nikko	Liaison	1	4	32' 8"	26' 0"	9' 8"	177.6	2 400	3 350	1 Lycoming GSO-480-B1A6 @ 340 hp	225
	LM	Nikko	Liaison	1	4	32' 8"	26' 0"	9' 8"	177.6	2 104	3 327	1 Continental O-470-13A @ 225 hp	186
	L 19E	Bird Dog	Liaison	1	1	36' 0"	24' 9"	7' 5"	174	1 638	2 340	1 Continental O-470-11 @ 210 hp	
Mitsubishi Heavy Industries Reorganized Ltd Aircraft Dept *Chiyoda-Ku Tokyo*	F-86F	Sabre	Fighter-Bomber	1		37' 1"	37' 6"	14' 7"	313.3	11 010	20 245	1 GE J47-GE-27 @ 6,000 lb. t.	600
	F104J	Star Fighter	Fighter	1								1 GE 779-GE-7	
	S-55A		Utility	1-2	10		42' 3"	13' 4"		4 880	7 200	1 P&W Wasp R1340-57 @ 600	110
	S-55C		Utility	1-2	10		42' 3"	13' 4"		5 185	7 500	1 Wright Cyclone 989 C7BA1 (R1300-3) @ 700	101
NETHERLANDS **Royal Netherlands Aircraft Factories (Fokker)** *Schiphol-Zuid, Amsterdam*	F-27	Friendship	Transport	3	32-40	95' 2"	77' 2"	27' 6"	754	21 830	37 000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp, or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105 eshp.	
	F-27	Friendship De-Luxe	Transport	2	10	95' 2"	77' 2"	27' 6"	754	23 000	37 500	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105 eshp.	
	F 27	Freightship	Pass./Cargo	3	22-40	95' 2"	77' 2"	27' 6"	754	21 300	37 500	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp. or 2 R-R Dart RDa. 7 Mk. 528 @ 2,105 eshp.	
	F-27M	Troopship	Military Transport	2	45	95' 2"	75' 6"	27' 6"	754	21 820	40 000	2 R-R Dart RDa. 6 Mk. 511 @ 1,720 eshp or 2 Dart 7 Mk. 528 @ 2,105 eshp.	

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Maximum speed, mph.
SPAIN **Construcciones Aeronauticas, S.A.** *Calle del Rey Francisco 4 Madrid (8)*	C-201	Alcotan	Transport	3	10	59' 4"	45' 1"	13' 5"	430	8 500	12 125	2 Enmasa Sirio E-1-20 @ 550 hp.	211
	C-202	Halcon	Transport	3	14	70' 8"	52' 5"	19' 0"	618	11 570	18 080	2 Enmasa Beta B-4 @ 770 hp.	230
	C-202B	Halcon	Business	3	6	70' 8"	53' 4"	20' 9"	600	13 365	21 276	2 Wright Cyclone R 1820/56 @ 1300 hp.	266
	C-207	Azor	Transport	4	30-40	91' 2"	68' 4"	28' 4"	921	21 600	31 900	2 Bristol Hercules 730 @ 2,040 hp.	285
	C-1131	Bucker	Trainer	2		24' 3"	22' 1"	7' 4"	145	1,000	1 550	1 Enmasa Tigre G-4-A @ 125 hp.	122
	C-127	Dornier	Liaison	1	4	35' 5"	31' 5"	11' 5"	216	2 100	3 400	1 Lycoming GO-480-B1A6 @ 274 hp	153
Aeronautica Industrial, S.A. *Plaza de las Cortes 2 Madrid 14*	AISA I-115		Primary Trainer	2		31' 3"	21' 1"	5' 10"	160.4	1 245	1 750	1 Enmasa Tigre G-IV-B @ 160 hp.	
	AISA I-11B		Touring or Training	1	2	30' 7"	21' 3"	6' 3"	114	925	1 474	1 Continental C-90-12F @ 90 hp	
	AISA AVD-12C		Liaison or Touring	1	3	34' 5"	25' 5"	6' 10"	163	1 654	2 800	1 Continental O-470-A @ 225 bhp.	
	AISA AVD-12		Liaison or Ambulance	1	2-3	36' 5"	26' 6"	6' 10"	163	1 875	2 425	1 Enmasa Tigre G-IV-B @ 160 bhp.	
La Hispano-Aviacion, S.A. *Calle San Jacinto 102-100 Sevilla*	HA 100-F1	Triana	Adv. Trainer	2		34' 1"	29' 5"	9' 5 1/2"	186.5	4 340	6 110	1 Wright Cyclone 9571 C7BA1 @ 800 hp.	229
	HA-100-E1	Triana	Adv. Trainer	2		34' 1"	29' 5"	9' 9 1/2"	198.0	4 380	6 450	1 Enma Beta B-4 @ 750 hp.	275
	HA-200-R1	Saeta	Adv. Trainer	2		34' 2"	29' 1"	10' 8"	187.2	3 998	5 995	2 Turbomeca Marbore IIA @ 880 lb. t.	435
SWEDEN **Svenska Aeroplan Aktiebolaget** *Linkoping*	Saab-J29F		Fighter	1	0	36' 1"	33' 2"	12' 3"	258	9 480	13 350	1 Sven RM-2 @ 5,175 lb. t.	660
	Saab 32A	Lansen	AW Attack	2	0	42' 8"	48' 1"	15' 3"		15 500	22 000	1 Sven RM-5 @ 9,500 lb. t.	706
	Saab-J32B	Lansen	AW Interceptor	2	0	42' 8"	48'	15' 0"				1 Sven RM-6 @ 16,000 lb. t.	700+
	Saab-32C	Lansen	Photo-Recon	2	0	42' 8"	48' 1"	15' 3"		15 500	22 000	1 Sven RM-5 @ 9,500 lb. t.	700
	Saab-35	Draken	AW Fighter	1	0	30' 10"	53'				16-18 000	1 Sven RM-6 @ 15,000 lb. t.	M 1.8
	Saab-J35B	Draken	AW Interceptor	1	0	30' 10"	53' 4"				16-18 000	1 R.R. RB 146 @ 13 200 lb. t.	M >2
	Saab-90A-2	Scandia	Transport	2	40	91' 11"	69' 11"	23' 3"	922	21 350	35 200	2 P&W R2180-E1 @ 1,800 hp.	277
	Saab-91B	Safir	Trainer	2	0	34' 9"	26'	7' 2"	146	1 540	2 315	1 Lyc. O-435-A @ 190 hp.	170
	Saab-91C	Safir	Personal	1	3	34' 9"	26'	7' 2"	146	1 325	2 385	1 Lyc. O-435-A @ 190 hp.	161
	Saab-91D	Safir	Trainer	3-4	0	34' 9"	26'	7' 2"	146	1 570	2 660	1 Lyc. O-360 @ 180 hp	169
	Saab-J35C	Draken	Dual contr Trainer	2		30' 10"	53'				16-18 000	1 Sven RM-6 @ 15,000 lb. t.	
SWITZERLAND **Pilatus Flugzeugwerke A.G.** *Stans Nr. Lucerne*	P-3		Trainer	2	0	34' 1"	28' 8"	10'	177	2 417	3 120	1 Lyc. GO-435-C2A @ 260 hp.	192
	PC-6	Porter	Multi	1	5-7	49' 10"	34' 5"	10'		2 400	3 960	1 Lyc. GSO-480-A7-A6 @ 340 hp.	
WEST GERMANY **Aero-Jodel** *Aero Flugzeugbau Hubert Zeitl Munich-Haunstetten*	D-11A	Aero-Jodel Lizid	Personal	1	1	27'	21' 1"	6' 0"		838	1 433	1 Cont. A-65-8 @ 65 hp	
	D-11C	Aero-Jodel Club	Personal	1	1	27'	21' 1"	6' 0"		838	1 433	1 Cont. C-90-12F @ 95hp.	
Dornier Werke GmbH *Friedrichshafen a. B.*	Do. 27 Q-3		Multi	2	2-4	39' 4"	32' 1"	9' 0"	208	2 270	4 718	1 Con. O-470-K @ 230hp	
	Do. 27 Q4		Multi	2	2-4	39' 4"	31' 5"	9' 9"	208	2 310	4 850	1 Lyc. GO-480-B1A6 @ 270 hp	
	Do. 28		Multi	2	2-4	45' 3"	29'	10' 4"	241	3 535	5 137	2 Lyc. O-540-A1A @ 250 hp.	
Scheibe-Flugzeugbau GmbH *Dachau*	SF-23A	Sperling	Utility	1	1	32' 4 1/2"	20' 1"	7' 2"	150.7	992	1 544	1 Con. C90-12F @ 95 bhp.	124.5
	SF-23B	Sperling	Utility	1	1	32' 4 1/2"	20' 1"	7' 2"	150.7	992	1 544	1 Con. O200-A @ 100 bhp.	127.5
	SF-23C	Sperling	Utility	1	1	32' 4 1/2"	20' 4"	7' 2"	150.7	1 036	1 610	1 Lyc. O-235-C1 @ 115 bhp.	134

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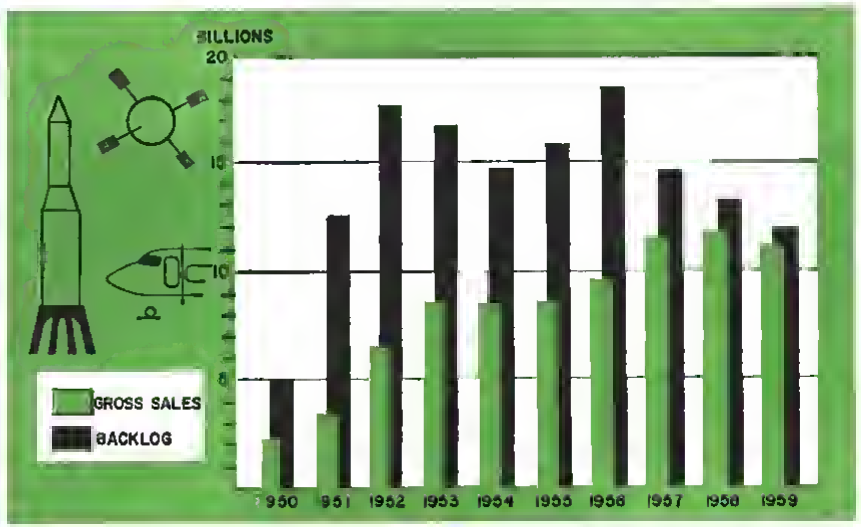


Write-Offs Swell As Industry Diversifies

By William H. Gregory

New York—If 1959 was the year of the great write-off for the aviation industry, then 1960 should begin an era of reaping the returns—maybe.

One executive of a major aviation company ran down a list for AVIATION WEEK of half a dozen projects his company had developed with its own funds. They covered a full technological spectrum from business and military utility aircraft applications to space and each one seems to fill a reasonable market need. But each one is tagged with a question mark: Will it ever be ordered in enough quantity to make any significant contribution to profits?

The industry, which has invested almost $2 billion of its own funds in research and development and facilities since the end of World War II has been able to pour such vast sums back into the business because of its generally high volume of sales.

Estimates for the 12 major airframe manufacturers for 1959 sales call for a figure little changed from 1958's $7.3 billion, according to the Aerospace Industries Assn.

Securities and Exchange Commission figures for a broader area of the industry—quarterly estimates based on a sampling of different companies for each period—show sales of $9,146 million for the first three quarters of 1959. Assuming fourth quarter sales on the same level, this would make for a total of approximately $12 billion.

Whether the industry can maintain this volume to underwrite its R&D costs, which may or may not begin to abate this year, is a dilemma that is causing some wry looks to be cast at phrases as "the soaring sixties."

Douglas Aircraft Co.'s decision only last month to build the French Sud Caravelle jet transport rather than commit itself to a new multi-million dollar development program for the DC-9 jet transport might be an important turn in the industry's investment trend.

Profits and profit margins are slumping. The industry is facing the prospect of having less to reinvest whatever its own preferences.

AIA's 12 companies earned $44.6 million in the first three quarters of 1959 compared with $105.8 million for the same period the year before. The broader SEC sampling showed profits of $147 million for the first three quarters, indicated a total for 1959 of just under $20 million.

For the first time in more than a decade, the industry's profits on net worth—that is, the return on the funds invested by stockholders or from profits in the business—dropped below those of general industry (AW Jan. 18, p. 101).

The comparable figures, using the third quarter of 1959 computed on an annual basis:

- **All industry—9.6%.**
- **Aviation—6.8%.**

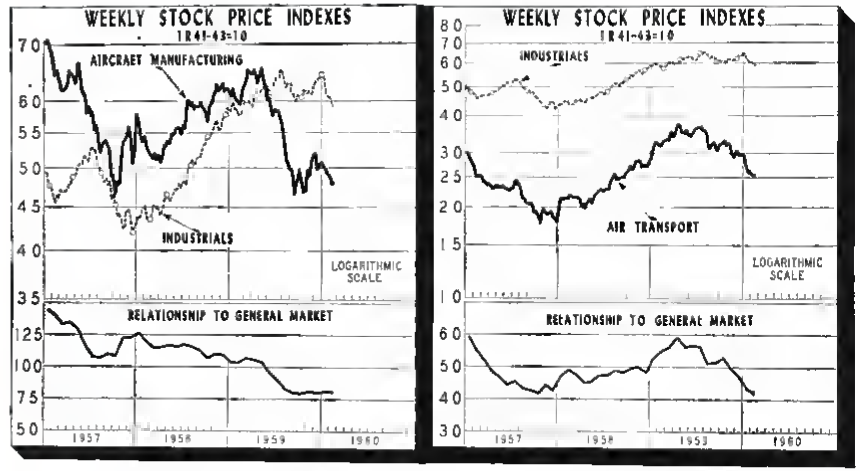
Comparing the third quarter of 1959 with the same quarter of 1958, the industry's profits declined 42%.

Various reasons are given for the drop: contract cancellations and stretchouts, shift to more low profit R&D contracts from higher profit production contracts.

Tougher competition may be the biggest factor of all, affecting volume as well as profits. More companies are fighting for less business, as indicated by the falling backlogs of aerospace companies noted by AIA—to $12.1 billion as of Sept. 30, 1959, from $13.2 at the end of 1958.

Boeing President William M. Allen summed up the situation graphically to the New York Society of Security Analysts:

"Five or six years ago a competition for Air Force business might have drawn 10 or 12 firms, today when we go to Wright Field or the space agencies, we find upward of 30 or 40 firms competing for major and minor contracts. Included in that group will be the auto producers, the major electrical firms, the principals in the electronics industry,



Source: Standard and Poor's

and of course, the principals in the aircraft business."

There is not enough money in the defense budget to support all the programs under way, Allen pointed out, and some must fall by the way. Furthermore, he added, the newer programs, as Boeing's Minuteman assembly contract, do not involve anything like the production effort or dollars that Boeing's B-47 or B-52 contracts did.

The result is likely to be falling sales volume or fewer companies—and in either case, fewer jobs.

Fiscal 1961 budget estimates excluding R&D, break down into:

- Aircraft—expenditures $6.02 billion compared with $6.67 in 1960; new obligational authority $4.75 billion compared with $6.14 billion in 1960.
- Missiles—expenditures of $3.47 billion for 1961 compared to $3.50 billion in 1960; new obligational authority $3.82 billion compared to $3.24 billion in 1960.

Individual Effect

By looking at a few companies individually, the effect of heavy write-offs and varying approaches to changing military and commercial markets can be applied to the industry as a whole.

- Boeing Airplane Co.

More than $134 million had been charged off on Boeing's 707 commercial jet program at the end of 1959 and the company was cautiously estimating deliveries in 1960 would improve its net earnings picture. But Allen expressed serious concern that further charges for product improvement might be necessary to keep Boeing competitive in this area that would upset this projection. Besides there was the specter of price concessions for the same reason. When or whether Boeing might recover its total investment seemed to be answerable only in the far distant future.

Boeing's merger with Vertol Aircraft Corp. was a step not only to complement its long range jet transport program but also in effort to broaden its capabilities in order to win more kinds of business to make up its expected loss of volume in its present military programs.

- Douglas Aircraft Co.

Douglas, which handles its DC-8 jet transport charges somewhat differently than Boeing, reported a $33,822,000 loss for 1959, primarily because of $57.8 million in charges against the DC-8 program which includes $51.5 million in inventory write-down. Douglas had spent a total of $236.7 million on the DC-8 through 1959. The Douglas method of handling charges concentrates them in the early stages of the program and the company expects deliveries of the transport this year to return the company to a profit basis before the year is out.

With the company only beginning to digest the charges on the DC-8, its motives on the financial side for the Canadelle agreement and the dropping of the DC-9 are apparent.

Military backlog has been declining for Douglas but the decision to proceed with the GAM-87A Skybolt air-launched ballistic missile should act to offset this.

- Fairchild Engine & Airplane Co.

Fairchild had to take drastic steps last year after the Air Force canceled its Goose missile and the company's J83 engine to power it. Charges on a commercial project also were important here for the company elected to change its accounting methods to write off those for the F-27 turboprop as they occurred. The company took a bitter dose in one big swallow—reporting a $5 million loss for the previous year, putting its brand new engine plant on Long Island on the block, closing its administrative offices at Hagerstown, Md., and consolidating operations at the airplane plant there.

F-27 orders crept toward a 100 plane breakeven point, but production was stretched out to keep the F-27 line open as long as possible to take advantage of any new orders which happened to be developing.

- General Dynamics Corp.

Commercial project charges were not such a crucial factor for this company during the year, but their effect was becoming noticeable. The company had charged more than $65 million to the 880 and 600 jet transports but it also had to consider the Canadair 540 Convair conversion, where the assembly line had to be shut down before enough sales interest had developed, and the CL-44D turboprop cargo transport. The company said its commercial jet write-offs would be smaller than other manufacturers—savings obtained, for

example by requiring the engine maker to deliver engines with acceptable suppressor-reversers and not having to underwrite this development itself. At the same time, however, it was looking into application of boundary layer control and other devices to increase the short field performance of its Convair 600 at the request of American Airlines.

Not to be overlooked either was the pungent remark of Earl D. Johnson, General Dynamics president, that "Today you can sell a jet transport to anyone you give the money to buy it." Trade-ins, price concessions, etc., were unquestionably threatening the profit margin potential of the commercial programs as offsets to low profit margin military business.

Already a widely diversified company, Dynamics continued this trend toward a hoped for 50-50 split by its acquisition of Materials Service, a large Chicago building supplies company.

• Lockheed Aircraft Corp.

Lockheed was especially aggressive in the diversification field—acquiring such varied elements as a ship building company, an electronics company and half interest in Grand Central Rocket Co., and a contract for construction of a monorail system in Seattle, Wash. These enterprises probably are not as diverse as they seem, however, for they might expand Lockheed's role in the missile and satellite systems it is already developing—Polaris for the Navy and the Discoverer, Samos, Midas family for USAF.

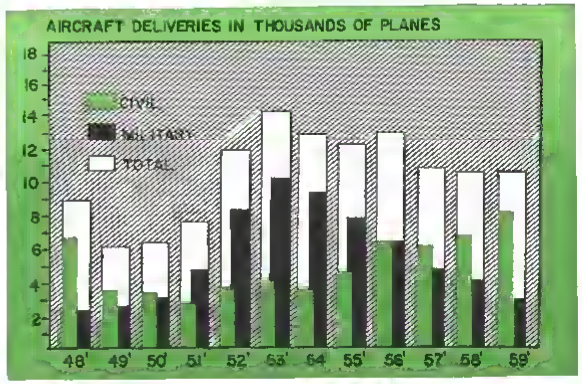
Lockheed's turboprop Electra commercial transport slipped into the background in airline excitement over introduction of the jets. But this program is the only one within striking distance of an overall break-even point. Lockheed has written off about $65 million on the project.

• North American Aviation

With most of its effort confined to military business, North American faced all the ups and downs of that business—notably cancellation of the F-108 and a drastic cutback of the B-70 Mach 3 bomber—but had no big commercial program charges to cope with. Now North American may face a decision on whether to enter the costly supersonic transport race because of its valuable B-70 experience in this area.

• United Aircraft

United spent last year or will spend this year about $70 million of its own funds in development of a widely varied group of projects to maintain its billion dollar volume. This year alone it will spend $40 million on facilities. It has spent money



U. S. Aircraft Industry (In Thousands)

YEAR	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft Parts and Equipment	Total
1959*	268 2	86 5	9 0	87 5	451 2
1958	291 5	89 9	12 2	85 7	479 3
1957	350 7	108 2	14 0	101 5	574 6
1956	329 8	104 4	11 3	95 3	540 8
1955	320 0	94 5	9 3	80 1	513 9
1954	343 2	105 9	11 5	89 8	550 5
1953	347 8	126 5	13 2	89 3	576 8
1952	311 6	98 8	10 4	62 7	483 5
Total Employment					
1959*	435 1	146 2	14 2	139 2	734 7
1958	457 2	152 6	18 3	129 5	757 6
1957	527 5	174 3	20 5	145 8	878 1
1956	499 1	165 6	16 9	132 8	814 4
1955	482 2	145 6	13 7	109 4	750 9
1954	497 8	166 8	16 1	125 2	805 6
1953	347 8	126 5	13 2	89 3	576 8
1952	311 6	98 8	10 4	62 7	483 5
Average Hourly Earnings of Production Workers					
1959*	$2 64	$2 64	$2 46	$2 58	$2 62
1958	2 51	2 54	2 37	2 49	2 51
1957	2 35	2 39	2 35	2 37	2 36
1956	2 27	2 28	2 27	2 29	2 28
1955	2 17	2 17	2 18	2 17	2 17
1954	2 08	2 09	2 09	2 07	2 08
1953	1 99	2 03	2 03	1 99	2 00
1952	1 87	1 98	2 05	1 88	1 90

* Preliminary Figures

on development of the J112 small turbine engine and for facilities and development for the Centaur liquid hydrogen rocket engine, both of which should begin a contribution to earnings this year, and for such projects as the Sikorsky S-60 flying crane helicopter which is not likely to do so this soon.

United sees retaining its billion dollar volume for the next couple of years, but earnings will be under pressure from development charges.

Now about 85% military. United is diversifying but probably not to the point where it will reach a 50/50 division. Its diversification philosophy probably reflects that of the entire industry: make it as wide as possible as long as the new venture is something the company knows how to sell (i.e., avoiding consumer products) has a profit potential.

This list stresses the airframe producers and their reaction to a changing technology and market. A similar list could be drawn to show how producers of subsystems have already entered the area as prime contractors for an entire vehicle or who may have the capabilities for doing so.

New Competition

Raytheon, already prime contractor for the Army Hawk low-level interceptor missile and the Navy Sparrow III air-to-air missile, moved into a new field last year with a proposal for a radio-powered helicopter for an early warning mission.

The proposal generated such interest with the Air Force that it knocked out a competition for an early warning airplane which Douglas, Boeing, Convair and Lockheed were strongly competing for and which could have provided a valuable supplemental program to the winner's transport program. This is a potent example of how new technical concepts are upsetting prospects for many companies.

Another significant case is that of Bendix Aviation Co., which not only won a prime contract for the Navy's Eagle air-to-air missile but also for the Air Force's 460L airborne weather reconnaissance system.

Important Changes

The latter may foreshadow greatly increased importance of various intelligence gathering systems which make use of earth satellites and aircraft as well as complex electronic equipment (see p. 219). These could mean important changes in the pattern of defense spending in industry, since companies like IBM, Radio Corp. of America, General Electric would be strong competitors for the primes with the vehicle manufacturers who are expand-

ing their capabilities in the avionics field at the same time.

Team efforts, with various major companies joined in sort of a prime contractor oligarchy, seemed to be a growing trend last year to solve the vastly multiplying technological problems of the newer weapons systems too large for a single company to handle. The Air Force cooled off interest if not killed this concept by refusing to go along with members of the team selected by the leader, and insisting that major subsystems be thrown open to new competitions. Many team members thus found they would be in a position of disclosing proprietary information in proposals to which their competitors had access to for the subsequent competition.

Some in the industry feel a new contracting management structure will appear in the defense industry. This might consist of:

• **Management contractor.** Such a group on the order of the present-day Space Technology Laboratories or the Mitre Corp. but probably divorced from any company connection, would be responsible for the overall technical management of a system in the manner the ballistic missile programs were handled through USAF's Ballistic Missile Division.

• **Participating contractors.** This envisions a system where development and hardware work would be parceled out on a subsystem basis to more or less independent prime contractors. There would be no managing prime contractor with subcontractors reporting to him as in the past. However, these independent contractors undoubtedly would be dealing with their own vendors for shelf items, though not as formal subcontractors.

With such companies as Avco Corp. and General Electric building re-entry nose cones for missiles and with rocket propulsion companies as Aerojet-General Corp. and Thiokol Chemical Corp. showing rapid growth there are vast opportunities for a change in the present complexion of the aerospace industry.

Balance Sheet

Looking at the balance sheet, there was little change last year in trends already established. Long term debt still was increasing and debt-to-equity ratios dropped slightly. The industry ratio last year of approximately $1.95 of stockholder equity to $1 of debt was well under the average for all manufacturing which ran about 4 to 1 for the same period.

This difference is not surprising because of the government contract dominance of the aviation manufacturing business, and its value as collateral, but

● SPECIFICATIONS

any marked continuation of the trend might mean a credit squeeze and the need for sale of equity securities to raise funds.

Some SEC figures for the industry comparing the third quarter of 1958 with the third quarter of 1959, show trends that may be significant:

	1958	1959 (in millions of dollars)
Net profit retained in business	40	12
Government receivables	1,122	983
Property, plant and equipment	1,790	2,035
Depreciation reserves	817	968
Long term debt	439	531
Stockholders' equity	2,286	2,413
Net working capital	1,596	1,744

Except for the net profits retained item which increased for manufacturing as a whole, these items generally followed trends in the all manufacturing category but were more pronounced.

Market Still Big

Standard & Poor's latest survey of the industry noted that with all the transition problems, dependence on the international situation, and technological advances the industry's sales potential remains big by any standard." Though there will be troublesome problems, 1960 should also be a better year for earnings, the survey concludes.

Both manufacturers and airlines had one common denominator last year that neither was likely to relish. That was a consistent decline in the market value of their common stocks and a consistent pattern for these stocks to be valued at well below the industrial average (see tables).

Part of this decline could be traced to the action of the investment trusts in selling large blocs in both groups, especially during the latter half of the year.

There is no simple explanation of this, for example, at least one fund took a big position in United Aircraft when it was paying a $3 a year dividend that produced a very respectable yield. When the dividend was cut last year, the fund was already disposing of its holdings.

One problem with the manufacturer's stocks was that the great growth of the industry during the Air Force buildup during and after the Korean War was largely unrecognized until just before the era of constant level budgets and a leveling off of the industry. Since then the market has churned up and down trying to decide whether the industry was a growth industry, a mature industry or in decline—all this mixed in with the normal rise and fall of the general list.

In the airline industry the decline

● **SPECIFICATIONS**

last year was partly due to pessimism on future growth and ability of airline managements to hold down costs and handle rapidly increasing depreciation and interest charges for its jet fleets. It also was a recognition of what bankers had been warning for some time—that the airlines would generate the cash to take care of their bank and insurance company debts for equipment, but that not much might filter down into earnings for the stockholder.

The declining market might be a discouraging sign for companies that would have to go to the public this year for funds. Capital Airlines, for example, one of the last of the airlines to complete its jet equipment program, was offering 909,659 common shares as part of its plan to pay for its Lockheed Electra and Convair 880 order. Each manufacturer was sharing in the financing.

Trans World Airlines had done no outside financing, but getting it was reported no problem. It was a matter of a nod from Howard Hughes, the airline's owner. Northwest Airlines planned to order Convair 880s, but its financing was yet to be arranged.

Most financing activity now is centered in the local service area, where very high debt equity ratios and the use of the Guaranteed Loan are providing controversial issues (see p. 157). Progress was being made in improving the equity situation in this area.

One question generating considerable interest in financial circles was whether the supersonic transport might upset the equipment life plans of airlines and demand a new round of financing.

Lenders' Views

Most airline financing consists partly of bank loans that run for a maximum of 10 years and the balance in insurance company loans which then become due and run for another 10 years or more. Lenders as a result would prefer not to hear anything about a supersonic transport before 1965 at the earliest.

If the airlines are able to handle their jet equipment loans gracefully, then a new round of jet orders will probably be financed easily.

At the same time, if airlines are forced into a supersonic transport order race sooner, the chances are the lenders will cooperate to some extent in self interest to keep their clients competitive.

Initial cost reports on subsonic jet transports appeared to be favorable, but such non-recurring items as transitional training and early maintenance bugs made them inconclusive. Though more expensive, jet engines' dependability may well cut the spares and replacement parts bill.

MIT Lincoln Laboratory's FPS-6 experimental tracker with 60 ft. dish near Wallops Island, Va. Modified SCR-584 is on trailer and slaved for aiming. Tracker, operating on 2790 mc., is used in an NASA project to determine radar signatures of re-entry bodies up to meteorite speeds.

Avionics

EARLY WARNING, reconnaissance, communications and data processing will play an increasingly important role in the future both to prevent accidental triggering of nuclear war and to assure effective retaliation in event of aggression. Ballistic Missile Early Warning System (BMEWS) installations, like one shown above in Greenland, and in Alaska and Britain will form cornerstone of warning network.

Deterrence Leans Heavily on Avionics

By Philip J. Klass

Washington—Within five years the United States and Russia will confront each other with sufficient numbers of thermonuclear warhead ballistic missiles to devastate each other's cities and lands, and pose a serious threat to each other's retaliatory capability.

The question of whether these two rivals can long live at nuclear sword's point will in large part depend upon ground based, airborne and space-borne electronic systems for warning, reconnaissance, communications and data processing. Such systems will have a dual role: to prevent accidental triggering of an all-out nuclear war and to assure quick and effective military reaction if it should prove necessary.

Without positive, reliable and fast warning, reconnaissance, communications and data processing, the situation in the mid-sixties can be likened to one where two men, each suspicious of the other and armed with a loaded revolver, are blindfolded, their ears plugged, and then are placed in a room together. Deprived of normal means of determining what the other is doing, suspicion alone or accidental body contact might easily trigger sudden death for both.

Recently the primary emphasis has begun to shift from the development and production of the weapons themselves to electronic warning, reconnaissance, communication and data processing systems.

Lt. Gen. Bernard A. Schriever, Air Research and Development Command chief, in recent testimony at the House appropriations hearings said "I would put satellite systems for warning, reconnaissance and communications in the very highest priority because of the great contribution that they can make to the over-all national posture, particularly our deterrent posture."

But as Schriever has previously stated, warning and reconnaissance systems, either space borne, airborne or ground based, are of little value in themselves without reliable communications and data processing systems capable of analyzing and transmitting information to key command centers and people that control the nation's power to counter an attack and to unleash a retaliatory attack.

The task of attempting to spot aggressive intent before actual attack is far more difficult for the U. S. than for the Soviet Union because of the Iron Curtain policies which restrict the flow of information and the travel of foreigners in the USSR.

Because the ballistic missile, which will form the backbone of the nation's defense against attack and offense if attack comes, is not subject to recall once it has been launched, U. S. policy is likely to be that missiles will not

be fired until there is "incontestable proof of aggression."

If this incontestable proof of aggression can only come when thermonuclear warheads begin to explode over U. S. aircraft and missile bases, then the nation faces costly hardening of missile and aircraft sites, and other key military installations, to assure the survival of a sufficient force to retaliate or to deter the enemy from attacking in the first place. As the accuracy of ballistic missile guidance improves and warhead yield increases, hardening becomes an economically, if not a physically, impossible task.

Positive Proof

If, however, the nation's scientists and industry can provide the positive proof of aggression 15-30 min. before enemy warheads could strike their targets, to permit launching all available missiles and bombers instead of only the fraction that might survive a nuclear attack, the deterrent effect on an aggressor is greatly magnified.

Gen. Thomas S. Power, Commander of the Strategic Air Command, in recent House appropriation hearings said: "There can be no real (nuclear) stalemate as long as the Soviets are in a position to tip the scales in their favor merely by taking the initiative (in making an attack). However, once we have reached the point where surprise attack can no longer prevent, or even minimize, retaliation, the initiative would give a potential aggressor only a temporary advantage which would cost him too much to make aggression worthwhile."

Early Warning

There are at least a few officials in the Defense Department who believe that the U. S. decision to build the DEW Line in the Arctic has acted as a powerful deterrent to Soviet aggressiveness and is responsible, at least partly, for the Russian switch from jet bombers to ballistic missiles. This belief is based on the fact that the DEW Line assured that any bomber attack would be detected several hours before SAC bases in the U. S. could come under fire, providing sufficient time for the U. S. to launch a powerful retaliatory force.

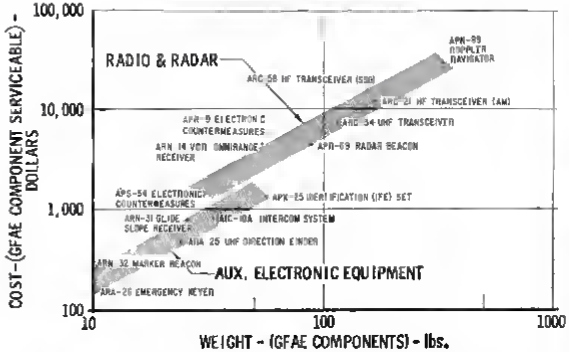
If an equally effective early warning network can be devised for ballistic missile attack, these officials believe that it will serve as an equally powerful deterrent.

The two Ballistic Missile Early Warning Systems (BMEWS) under construction in Greenland and Alaska, and a third slated for construction in Britain, are the first links in an ICBM early warning chain which the U. S. hopes to erect.

Each of the BMEWS sites, equipped

USAF Electronic Support Systems

System No	Name and Mission	Status	Prime Contract
412 L	**Air Weapons Control System:** Local air defense system in both mobile and fixed versions, to provide early warning tracking and destruction of air-breathing targets by interceptors and Bomarc missiles.	Development/ Production	General Electric
413 L	**Dew Line Improvement:** Modification of existing facilities and introduction of improved equipment.	Under Implementation	Federal Electric Co.
416 L	**SAGE Air Defense System:** Automatic data processing system for command and control of continental air defense against air-breathing targets.	Under Implementation	No single prime
425-L	**Naval Combat Operations Center:** Automatic data processing and display system in hardened site to provide Naval Commander with instant access to status of air defense forces and means to control such forces.	Under AF study	No contract
431-L	**Traffic Control and Landing Systems:** Development and implementation of ground and airborne navigation aids. Much of this function is now performed by Federal Aviation Agency.	Under Implementation	No single prime.
433-L	**Weather Observation & Forecasting System:** Integrated system of observing, reporting and processing weather data for quick use. Program is joint one with FAA and Weather Bureau.	Development	United Aircraft Corp.
438-L	**Intelligence Data Handling System:** Data processing and display system to intelligence data gathered by variety of means from world-wide sources.	Two First-Phase Study Contracts Complete	General Electric IBM
463-L	**AMC Logistics Data System**	Under Implementation	No Single Prime
465 L	**Strategic Air Command Control System:** Automatic data processing and display system to provide SAC Commander with instant access to status of SAC forces and means to control such forces.	Development	International Tel & Tel
466 L	**Electromagnetic Intelligence System:** Program to integrate number of individual ground and airborne systems used to gather intelligence by electromagnetic radiation methods.	Study/Design	Radio Corp. of America
470 L	**Polar Communications Satellite**	Development	Bendix Aviation
473 L	**Air Force Control System (Globe Guish):** Automatic data processing and display system to provide AF Chief of Staff and senior officers with up-to-the-minute status report on all USAF field forces.	Under AF Study	No contract
474-L	**Ballistic Missile Early Warning System:** Three installations for detection and tracking of ballistic missiles.	Under Implementation	Radio Corp. of America
488 L	**Air Communications System (AirCom):** Long-range program to expand capability of existing AF global communications system to increase capacity, assure ability to serve other support system functions.	Study/Design	ITT Communications Systems, Inc.
496-L	**Space Surveillance Center:** Facility for keeping track of all space vehicles U. S. and others. Center will use existing AF, Army, Navy and NASA tracking facilities, expanded during coming years to handle future needs.	Under AF Study	No prime contractor



Boeing Uses Weight to Estimate Costs

Relationship between cost and weight of government-furnished avionic equipment used on the B-52 is shown in chart above, prepared by Boeing Airplane Co. Analysis was made by Boeing to provide convenient rule-of-thumb technique for estimating cost of new weapon systems based on avionic equipment weight. For example, basic radio and radar equipment costs about $75 per pound while auxiliary avionic equipment averages about $25 per pound. Chart is from a technical paper by Russell E. Wroslow of Boeing.

with three or four huge surveillance radars capable of detecting ICBMs at ranges of 2,000 mi. or more, will provide an estimated 15 min. warning time, roughly half of the missile's total flight time. In addition each site will have several precision radars with which to track the missiles. Tracking radar signals will be analyzed by computers to determine whether the object follows ballistic trajectory in order to discriminate between missiles and other space objects, such as meteorites.

The BMEWS station in Greenland is expected to have its surveillance radars in operation within several months, with the tracking radars operational before the end of the year. When the Alaska station becomes operational, in 1961, Defense Department officials will breath a little easier, but not much.

For SAC bombers, which can be recalled, BMEWS will provide the alarm to send all available aircraft, fully armed, on the way to their targets, removing them from the danger of nuclear devastation, but subject to recall if the alarm proves false.

However, because radar is not an infallible detection means, BMEWS by itself probably will not provide the "incontestable proof of aggression" required to unleash U.S. ballistic missile attack, at least during a time of relaxed international relations. In a tense international crisis, the situation might be different.

A number of other ICBM detection techniques are under investigation, aimed at providing additional substantiating evidence of attack and additional warning time. These include:

• **Project Midas**, an early warning satellite to be equipped with infrared sensors which can detect the firing of salvos of ICBMs at the time of launch, providing twice the warning time available from BMEWS. Project Midas presently is in the research and development stage, but Gen. Schriever says that a decision to proceed with the program on a weapon system basis may be made soon. Earliest implementation date would be sometime after 1965 for an operational satellite system.

• **Project Teepee**, a form of radar that operates in the high frequency (HF) band, detecting echos produced by energy reflected from ionized trails produced by rocket engines, is one of about half a dozen techniques under investigation which utilize ionosphere reflection and lower frequencies to achieve very long ranges (AW Feb. 8, p. 23).

Although the ballistic missile and thermonuclear warhead have made the air defense problem economically if not physically impossible of solution, they have in at least one sense greatly simplified the overall problem of early warning.

If an aggressor launches an all-out attack it must be just that. The launching of every missile must be perfectly timed and coordinated to assure that all warheads begin to strike at approximately the same time. Unless a major portion of the U.S. retaliatory power is wiped out in the first blow, the attacker can be sure that much of his country will be devastated before the day is over.

This means that several hundred ballistic missiles must be launched by an

attacker within an interval of perhaps 15 min. This mass salvo should provide early warning radars and satellites with an attractive easily detected target and provide something approaching incontestible proof of aggression.

Whether the President, and the American public, will act upon the intelligence contained in a few faint echos of electromagnetic radiation, when such action means the launching of ballistic missiles which can not be recalled, is impossible to predict today. It will depend upon the mood of the time and the man in the White House.

Reconnaissance-Intelligence

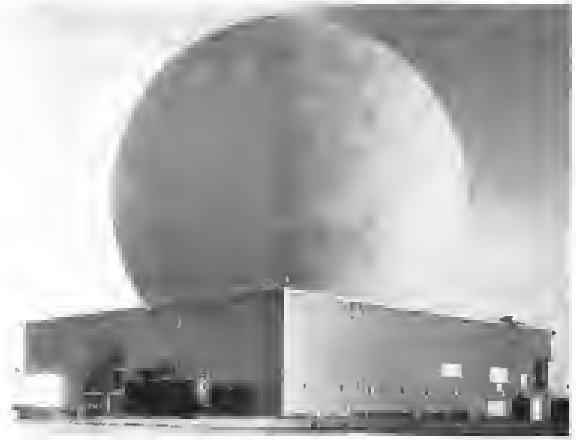
Before taking so fateful a decision, it is likely that the President would ask for additional evidence to support the radar indication of aggression. At most assuming that missiles are detected at time of launch, the President will have perhaps 20 min in which to assemble and weigh all possible evidence, at worst he may have less than 10 min. If word comes in the middle of the night, and the President must shake the cobwebs of sleep from his mind, half of the available time for the fateful decision could be lost.

The circumstantial supporting evidence of intent to attack might be found in many small, perhaps unrelated, bits of intelligence. For example, had long-range communications suddenly been blacked out within recent minutes by a Project Argus type nuclear explosion in the upper atmosphere? Had there been a sharp change in the amount, or type, of enemy military radio traffic in recent days? Had intelligence agents reported any unusual activity or incidents in recent days? Had sizable numbers of enemy submarines been detected in the vicinity of the U.S.? There are dozens of others.

In times past, when a surprise attack did not give an aggressor so great an advantage, a President had hours, days, or even weeks to assemble such intelligence data and evaluate it, with the aid and counsel of many experts. In the age of ballistic missiles and thermonuclear warheads there will not be time for such consultation. The decision will be that of one man alone.

The problem of detecting an enemy's intent to attack from the vast amount of intelligence data available on his recent actions is in many ways comparable to the problem of detecting a faint radar echo in the presence of high background noise.

In somewhat the same way that digital computers and data processing equipment are being applied to the problem of sorting a faint radar echo from background noise in extremely long-range radars, computers and data



BMEWS tracking radar antenna, housed inside a glass fiber radome, sits atop a 3-story high building which houses transmitter and receiver. Installation is prototype under test at RCA's Moorestown, N. J. facility.

processing systems must be applied to the problem of sorting enemy intentions from the great mass of intelligence information available.

This intelligence data may come from a Project Samos type reconnaissance satellite, from reconnaissance aircraft photos, from monitoring enemy radio and radar, from our own probing radars, or from individual intelligence agents.

But nuclear missile warfare will not permit such intelligence information to slowly filter up by word of mouth and written reports through many individual agencies to be correlated leisurely if at all. If a President should ever face the fateful decision he must be able to instantly interrogate an ever-alert, ever-awake central data processing system which is prepared instantly to provide answers to any question he may pose, and whose answers are up to the minute, not days or weeks late.

Two USAF Programs

The Air Force currently has two several programs which could serve as the cornerstone for such an automatic national intelligence processing system.

- **Electromagnetic Intelligence System**, 466 L, a program to integrate various sub-systems used to collect and analyze radio and radar signals and transmissions of potential enemy countries. The system presumably includes collection of information on enemy radar frequencies and other characteristics for use in developing U.S. electronic countermeasures. Recently Radio Corporation of America and International Business Machines Corp. received contracts covering system integration of several existing programs.
- **Intelligence Data Handling System**, 438 L, is a program to apply automatic data processing and communications to the transmission, processing, correlation and display of intelligence information from a variety of sources including the Electromagnetic Intelligence System (466 L). Program currently is in the study stage with parallel studies under way at General Electric and IBM.
- **Strategic Air Command Control System**, 465 L, being developed by International Telephone & Telegraph Co., is intended to provide the SAC Commander with instant access to information on the availability and disposition of SAC's worldwide forces.
- **Naval Combat Operations Center**, 425 L, intended to provide the Naval Commander with instant access to information on the disposition and availability of an defense forces in the U.S. and Canada, and the necessary communications for control of such forces. Contractor has not yet been selected for this support system.
- **Air Force Control System**, 473 L, is intended to provide senior air staff officers with instant access to information on disposition and availability of all forces and support groups within the USAF. This system would serve the Air Force chief of staff in somewhat the same way as a national intelligence system would serve the President. Air Force has not yet decided whether to proceed with the program implementation.

In recent months there has been growing recognition in the Air Force

that much of the intelligence information which it seeks for its own strategic bombing and air defense missions also is required by other military services and agencies. The Navy, for example, with Polaris submarines and carrier-based aircraft capable of delivering nuclear weapons, needs to "get the word" as quickly as SAC or Norad. The Army has similar needs because of its local air defense mission and this would be even more necessary if Nike Zeus were to be implemented. Each service has its own communications and data processing systems.

This has prompted some Air Force officials to start talking about the need for a single, unified national military intelligence and control system, or at least an effort at unification of the many systems now in use or under development by individual services and agencies.

"It is as logical as the single central nervous system and brain in the human body," one observer points out. "Imagine the difficulty of defending yourself in a fight if each arm and each leg had its own separate nervous system and brain."

Integration Problems

Air Force officials recognize that within their own service there is a great need to integrate and unify the intelligence, command and control systems which have multiplied almost like rabbits in the past several years.

For this purpose USAF has recently formed a group, known as the Winter Study Group, whose objective is to carefully analyze and determine the type of support systems the Air Force will need to perform its mission after 1965. This will include such elements as target detection and data acquisition means, data processing, display, command communications and weapons control.

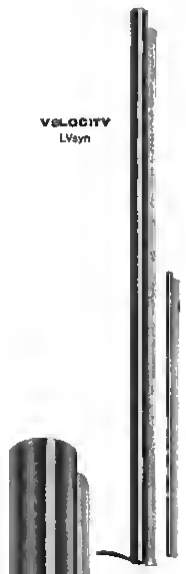
The Winter Study Group, headed by Lt. Col. John L. Lombardo of ARDC's Command and Control Development Division and John F. Jacobs, technical director of the Mitre Corp., has in turn formed nine panels of technical experts, each to investigate one area of the over-all problem. These include data processing, display, communications, sensors, logistics, human engineering, equipment utilization and cost. The Winter Study Group is expected to analyze existing USAF support system programs to determine whether two or more of them should be integrated to provide greater flexibility and/or reduce program cost. For example, certain functions may require data processing facilities only before hostilities break out but would find little use for them thereafter, while other functions require data processing functions primarily after the outbreak of hostilities.

The group also will consider the question of whether data processing facilities should be leased rather than purchased to minimize capital investment and to minimize the risk of obsolescence.

The Air Force study will lean heavily on technical personnel in the Mitre Corp., Lincoln Laboratory, Space Technology Laboratories, System Development Corp. and Rand Corp., as well as major ARDC centers and operating commands. Final report and recommendations are not expected before late spring or early summer.

Some observers speculate that out of this "systems look" at the whole Air Force requirement for intelligence, command and control support systems may come the basic concept for a system which could become joint service or even national in its eventual scope.

In any event, it appears more than likely that an increasing share of defense funds will be spent for improved and new communications, data processing, reconnaissance and early warning systems and devices during the coming decade. These will be predominantly space-borne and ground based systems and devices, rather than predominantly airborne as in the past.



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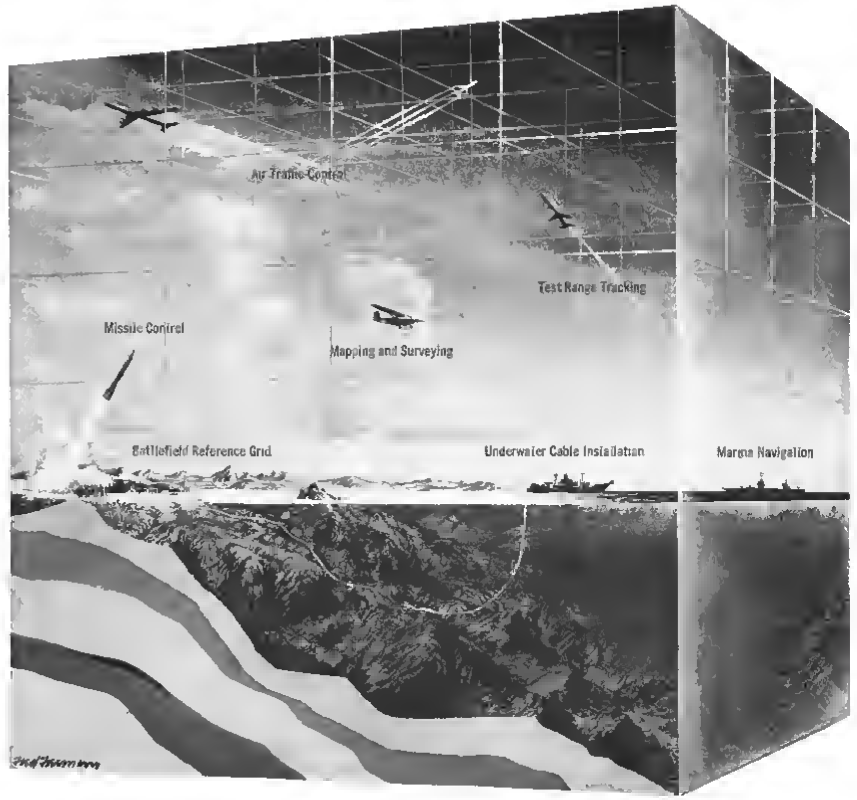

LORAN C: ACCURATE POSITION DATA IN EVERY DIMENSION

A new navigation system — Loran C by Sperry — now makes it possible to determine the position of aircraft and ships with far greater accuracy, and over a much greater range than ever before. Sperry is currently fulfilling test instrumentation and marine navigation contracts with the Services for this new system.

But a wide variety of tactical applications suggest themselves. For instance, Loran C can be applied to air-sea rescue, surveying, mapping, air traffic control, underwater cable laying and repair. It can provide position tracking for ships, aircraft, missiles, and satellites. It can be used to develop a battlefield reference grid to increase the effectiveness of field operations. And it can provide a highly precise time as well as position reference.

Developed by Sperry in cooperation with the Armed Forces, Loran C is a unique hyperbolic system which is not limited to line of sight. It extends the range of loran transmissions to 1500 miles and beyond . . . operates at ground level as well as at altitude. Compatible with the Loran A system, Sperry's Loran C is an advanced version of what has been called the most important radio navigation development of the postwar era. It is the most accurate long range area coverage system in operation.

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Circle Number 231 on Reader Service Card

BELL Aircraft automatic landing system, now under evaluation at FAA's Atlantic City, N. J., facility, is one of three basic types of all weather landing systems which FAA plans to test during the coming year to determine which type should be adopted.

FAA Seeks Increase in R&D Funds

Washington—Federal Aviation Agency is seeking $65 million for research and development in Fiscal 1961, an increase of nearly 30% over its previous year's appropriation.

The bulk of these funds will be used to continue and evaluate important development programs already under way rather than to launch major new projects, according to present plans.

One important new development program, which will be launched with Fiscal 1960 funds, is a minimum cost air traffic control transponder for use by small business and private aircraft. FAA is expected to call for industry bids on the project within the next few weeks.

FAA already has begun to receive and to test experimental hardware coming out of important development programs initiated during the past several years. Additional hardware is expected to undergo evaluation during the coming year.

• **Semi-automatic traffic control:** First elements of the automatic data processing and display system for traffic control, which General Precision Equipment Corp. is developing, have been delivered to FAA's National Aviation Facilities Experimental Center (NAFEC) in Atlantic City. This includes digital computers, built by Librascope, which are now undergoing preliminary test. By this summer, FAA hopes to have sufficient equipment on hand to begin system experimentation tests, which are expected to continue until early 1962.

• **Automatic Ground-Air Communication System:** Tests recently have started on the data link system (AGACS) developed by Radio Corporation of America, which is expected to eliminate the need for voice communications for much routine traffic between aircraft and ground controllers, as well as provide faster and more reliable exchange of data. (AW July 28, 1958, p. 70.) FAA is seeking Fiscal 1960 funds to purchase 20 airborne prototype equipments this fall for full service tests.

• **All weather landing systems:** Within the next several months, FAA expects to have three basic types of all-weather landing systems under evaluation at NAFEC. By the end of the year FAA hopes to select the system it will adopt. The three basic types include the AN/GSN 5, developed by Bell Aircraft which employs a precision ground-based radar and associated computer, Regal, an acronym that stands for Range and Elevation Guidance for Approach and Landing, developed by Gilfillan, a ground-based system operating at microwave frequencies which gives pilot a choice of approach angles and provides direct cockpit indication (AW May 18, 1959, p. 137), and airborne flare-out couplers, one developed by North American's Autonetics Division, the other a British design, which employ radar altimeter, airborne computer and other elements to compute flare-out path for pilot. In flight evaluation of the different systems, FAA plans to use a variety of aircraft types, including a KC-135 jet tanker, an F-102 interceptor, an Aero Commander and a Grumman Gulfstream turboprop transport.

• **Taxing and Routing of Aircraft Control Equipment (TRACE):** System for determining and displaying the location of all aircraft on airport taxi strips and runways, developed by General Railway Signal Co., is now being installed at NAFEC and evaluation should begin shortly. The system employs magnetic sensors which are buried in the runway and taxi strips. Airborne Instruments Laboratory is also under contract to provide an alternative sensing device, a modification of the simple doppler radars used for highway speed enforcement. A modification of TRACE techniques may be used for traffic control of buses which will trans-

Status of Major FAA Facilities

	In Operation Jan. 1, 1960	Total Programed Thru FY '60	Requested In FY '60 Budget
VHF Omniranges	661	769	20
VOR-Tacco Installations (VOR portion included in VHF Omniranage figures)	76	558	42
Enroute (long-range) Radar	33	67	12
Airport Surveillance Radar	48	82	0
Precision Approach Radar	11	23	0
Instrument Landing System (ILS)	174	230	20
Airport Surface Detection Radar	3	10	0
Radar Beacons	19	78	42
Approach Light Systems	102	157	17
Sequence Flashing Lights	41	102	72
Remote (Peripheral) Common. Outlets	225	281	N.A.
Air Traffic Comm. Stations*	417	420	N.A.
International Air Traf Comm Stations	11	12	N.A.
Air Route Traffic Control Centers	35	36	N.A.
Airport Traffic Control Towers	222	266	13
Electronic Computers	4	6	N.A.

* Includes ATCS combined with Airport Traffic Control Towers
N.A. Not Available at present.

port passengers from the terminal building to their aircraft at Washington's new Dulles International Airport, now under construction.

• **Minimum-cost DME-T.** First prototype of a moderate-cost distance measuring equipment, being developed by National Aeronautical Corp. (Narco), is scheduled to be delivered to NAFEC in April, with several additional models to be delivered in September.

• **Height determining radar.** Novel passive height-finding radar being developed by W. L. Maxson Corp. which will utilize echo-energy produced by airport surveillance radar transmitter to determine altitude of airplanes in the terminal area, is slated to begin evaluation before the end of the year.

International Cooperation

In an effort to prevent a repetition of the unfortunate Decc Vortac conflict Britain and the U.S. will jointly plan and evaluate two competing navigation systems for transatlantic use. One is the British Decca system, the other is the U.S. developed Loran-C. Three top British representatives are now stationed in the U.S. with FAA, while three FAA specialists are working similarly in Britain with the Ministry of Transport.

The FAA facility at Atlantic City is fast becoming an international center for test and evaluation of aviation facilities. The list of foreign nations having representatives now stationed at NAFEC or planning to spend at least short tours there include Britain, France, Germany and Japan.

Progress Cited

James L. Anast, chief of FAA's Bureau of Research and Development, is pleased with the rapid progress that has been made to date in converting the old Naval Air Station at Atlantic City to the new National Aviation Facilities Experimental Center. NAFEC now has personnel and facilities capable of conducting scientifically competent evaluations of new ideas, techniques and equipments in a minimum of time, Anast says.

As an example, Anast cites recent NAFEC evaluation of the operational utility of pictorial displays in which the tests were planned and conducted, the results analyzed and a report written less than two months after decision was made to conduct the evaluation. With this growing in-house capability, Anast expects that BRD will contract out less of its studies and analyses than previously.

Anast also warns that FAA intends to take a tougher view of contractors who overrun either their original financial estimates or timetables.

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Solid State Electronics Trend Goes On in Plant and Laboratory

By Barry Miller

Mounting acceptance of solid-state electronics was apparent again last year in the avionics industry. And it is clear this trend will continue.

This is reflected only partly in the increased production of solid-state devices but is far more apparent in the stepped up over all research and development of solid state materials, devices and techniques at almost every major avionics laboratory throughout the country.

Much of the R&D effort is invested in what have become the conventional solid-state components, transistors and diodes and the materials and techniques appropriate to their fabrication. Other work is directed at more exotic devices—some made possible by the transistor some several years old but not fully developed and finally what may be the ultimate at least in lower frequency and low power components—the completely solid state circuit.

To a considerable degree these efforts are sparked by the military and space programs and their demands for more reliability, less size and weight and reduced power consumption in avionic equipment.

Here are some of the areas in which solid state work is being pressed.

● **New materials**—There is an unending quest for new semiconductor, magnetic and ferroelectric materials. In semiconductors suitable for transistor type devices alone, for example, scientists are seeking new materials and are re-examining others as crystal growing and control techniques improve. Despite the promise of the Group III-V compounds, such as gallium arsenide and gallium phosphide, only a handful of Group III-V compound diodes are available in a device market dominated by germanium. Yet some of these compounds are expected to play an increasingly important role in transistor-type devices because of the potentially high frequency and high temperature operation they offer.

Several laboratories—General Electric, Westinghouse, IT&T Laboratories and Air Force Cambridge Research Center among others—have programs in silicon carbide, another promising semiconducting compound. The obstacle has been the growth of large, high-quality, single crystals—a barrier several laboratories hope to surmount in the near future. Other types of materials, including diamond, display semiconducting properties which may be of value in transistors or diodes.

Another group, ternaries, compounds made up of three elements, are relative newcomers among the promising materials for semiconductor devices. First studied for their thermoelectric properties some of these compounds have tested properties such as high mobility which conceivably may make them useful as transistor or diode materials.

● **Thermoelectricity**—Need for spot cooling in avionic gear, cooling of infrared detector cells for satellites, power sources for satellites and refrigeration and for air conditioning in missile-bearing submarines has revived interest in the century-old Seebeck and Peltier effects. The Seebeck effect for years valuable in laboratory thermocouples involves the generation of a potential across a load by heating the junction of two dissimilar metals or semiconductors. Analogously, the Peltier effect is the heating or cooling at a junction of two elements produced by a current flow through them.

Research in this field at over 100 laboratories in this country is concerned primarily with a search for materials—in some cases gaseous and liquid as well as solid—which have high Seebeck coefficients, high electrical conductivity and low thermal conductivity. Materials being investigated include a host of organic and inorganic compounds far greater in number and broader in nature than those applicable to transistor devices.

Limited application of Peltier spot cooling of electronic circuits is already a reality. Moreover the Navy Bureau of Ships has contracts totaling about half a million dollars with RCA, Carrier Corp. and Whirlpool for the study of thermoelectric cooling and refrigerating systems for its future undersea forces.

Because materials generally display optimum thermoelectric properties over only a restricted temperature range, spacehorne auxiliary power sources may consist of a series of graded thermoelectric materials, perhaps in conjunction with thermionic converters at extremely high temperatures as the most effective type of generator design.

Another possible power source involving solid-state materials showing some promise is the ferroelectric converter. Unlike thermoelectric sources which deliver d-c, this device can supply high-values of a-c. It utilizes the change in the permittivity of a charged ferro-

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electric capacitor to convert thermal into electrical energy.

Both thermoelectric sources and the ferroelectric converter may join solar batteries as useful solid-state space power sources.

• **Hybrid tubes**—For years, a handful of researchers have sought to eliminate a principal source of tube failure and power consumption by replacing the hot cathode of an electron tube by an electron emitting semiconductor junction.

Emission of electrons from the surface of a semiconductor junction has been observed in silicon, diamond, and silicon carbide in varying current densities at Bell Telephone Laboratories, RCA, Westinghouse and elsewhere. These observations have sparked the hope of bringing the density of electron emission up to a level necessary for tube operation.

• **Superconductive devices**—Like thermoelectric effects, the phenomenon of superconductivity—the ability of certain metals, usually poor conductors at room temperature, to lose all resistivity when cooled to temperatures near absolute zero—has been known for years. Interest in superconductivity revived five or six years ago with the late Dudley Buck's suggestion of a low-temperature switching element—the cryotron—for use in small, low power computers. Work on the cryotron and related superconductive devices has evolved from wire wound to thin film devices whose broad application according to many in the field awaits impending solutions of cooling, materials and film deposition problems. Other devices, employing superconductivity—such as gyroscopes, bolometers, detectors and electromagnets—are now attracting close attention. It appears that the interest in superconductivity, stirred by the cryotron, may lead to a multiplicity of devices in areas apart from computers.

• **Tunnel diodes**—Tunnel or Esaki diodes are one of the latest additions to the designer's bag of solid-state tricks. This device promises very high frequency operation (the kilomegacycle region has already been reached), it doesn't require the high degree of crystal purity and controlled doping which plagues the transistor manufacturer. It can be fabricated from high temperature materials and is less susceptible to radiation damage than transistor devices. There is belief that it can be made cheaply, and if so, it should make sizable inroads in the device market for possible applications as switching elements in memory and logic systems of computers, as amplifiers, oscillators, mixers and converters.

• **Low-noise amplifiers**—Need continues for low-noise amplifiers to extend the range of communication systems on earth and in space, to stretch the "eyes"

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Maximum Source Impedance	5 K ohms on 10 microvolt range only, noncritical all other
Automatic Features	Ranging, polarity

DC VOLTAGE SPECIFICATIONS Apply to all instruments except those incorporating the pre-amplifier

Range	± .001 to ± .999d ± 1.000 to ± 9.999d ± 10.00 to ± 99.99d ± 100.0 to ± 999.9 v
Accuracy	0.01% ±1 digit
Input Impedance	1000 megohms to ± 9.999 v, 11 megohms to ± 999d v
Average Reading Time	50 milliseconds
Max. Balance Time	200 milliseconds
Operating Ambient Temperature*	0-50°C
Automatic Features	Ranging, polarity

DC RATIO SPECIFICATIONS Apply to all instruments measuring DC ratios

Range	.0000 to .9999*
Accuracy	±1 digit
Input Impedance	1000 megohms
Average Reading Time	50 milliseconds
Max. Balance Time	100 milliseconds
Reference Voltage	10 volts ±10% (nominal)
Reference Input Impedance	1000 megohms
Operating Ambient Temperature	0-50°C

*With properly chosen reference supply, ratios of up to 100 times unity may be measured

AC VOLTAGE SPECIFICATIONS Apply to all instruments measuring AC voltages

Range:	.0000 to .9999 VAC 1.000 to 9.999 VAC 10.00 to 99.99 VAC 100.0 to 999.9 VAC
Accuracy	0.1% and two digits
Frequency Response	30 cps to 10,000 cps
Input Impedance	1 megohm shunted by 30 mmfd up to 9.999 VAC 10 megohms shunted by 30 mmfd up to .999 d VAC
Average Reading Time*	2 secs low freq, ½ sec high freq (400 cps and up)
Operating Ambient Temperature*	0-50°C
Automatic Features:	Ranging

RESISTANCE SPECIFICATIONS Apply to all instruments measuring resistances

Range*	.000.1 ohms to .999.9 ohms, 1.000 ohms to 9.999 ohms, 10.00 K ohms to 99.99 K ohms, 100.0 K ohms to 999.9 K ohms
Accuracy*	0.01% ±1 digit to 99.99 K ohms, 0.03% ±1 digit to .999 d K ohms
Average Balance Time	200 milliseconds
Operating Ambient Temperature	0-50°C
Automatic Features	Ranging (decimal point placement)

ELECTRICAL OUTPUT SPECIFICATIONS- Apply to all instruments incorporating electrical outputs

* Both 2-4-2-1 Binary Coded Decimal and 10 Line Coded Decimal are provided

of radar systems and in and radio astronomy in picking up far distant radio emissions The diode parametric amplifier appears to have won widespread acceptance in some of these applications For extremely low-noise operation in other applications especially in the X band and beyond, the cooled solid state Maser offers considerable advantage Air Force funded efforts are under way to push Maser operation to higher frequencies—into the millimeter and optical wave regions as well as down into the RF region Industry sources reason that where extremely sensitive receivers may be needed a completely cooled device with microwave Maser preamplifier, RF Maser IF amplifier superconductive mixer and other cooled solid state components may emerge

• Molectronics—It is in the area of future microminiaturized devices or circuits that many of the techniques, experience, materials and interests of solid state engineers and scientists may merge Programs in this area are under way at dozens of avionic companies It appears likely that as the concept of a completely molectronic circuit, in which there are no identifiable components as such, is accepted and applied, the function of the device or circuit engineer will change Solid-state materials properly grown and fabricated will be the given subcircuits or circuits which the engineer might ordinarily design but which he will eventually only tie together into a system

Much work remains of course before this concept, its many competing programs philosophies and in some cases conflicting terminologies, come to fruition It will not happen in the next year or two as a few of the more ardent advocates of this solid-circuit suggest, but the future of component development under the impact of solid-state physics points in this direction

New Antenna

Broadband antenna for high speed aircraft, which has a VSWR of less than 4 1 over frequency range of 80 to 400 mc , weighs 8½ lb , is now available from Land Air Inc., Chicago, Ill The Model LA 80-320 can withstand shock and vibration of MIL-A-18376A according to manufacturer.

Kamon H 43B Huskie Air Force rescue and utility helicopters in flight test

Helicopters

VERTOL YHC-1B MOCKUP WITH H-21 IN BACKGROUND

Change, New Concepts Set Helicopter Pace

Helicopter development, with the influence of the turbine distinctly evident, is forecast to intensify in tempo in the early 1960s

Sales over the past year generally were down as the industry converted from piston engines to gas turbines. Benefits of new turbine engines—their lower operating and maintenance costs, greater power, practicality for light as well as heavy helicopters—should create a demand for new or replacement rotary wing aircraft.

Potential of the commercial helicopter market has yet to be plumbed fully. Military development funds and production quantities still govern commercial helicopter economies.

Military tendency is to reduce the types of helicopters in their inventory—which could mean increased production quantities of fewer types. There is also a growing Defense Department policy of two or more services using the same types of helicopters to as large an extent as possible.

During 1959 the significant industry trend was a continuation of developments already apparent: increasing development and production of the turboshaft helicopter, experimental research for new propulsion techniques (tip burners, tip rockets, nuclear energy) and continued search for new or improved VTOL or STOL techniques (tilt wings, tilting propellers, jet and rotor-prop flap systems).

The next generation of rotary wing aircraft will have multi-engine reliability and greatly reduced maintenance costs. Rotary wing aircraft having speeds of 250 kt. and helicopters capable of carrying payloads of from 20 to 40 tons can be built during this period, says Philip L. Michel, chief of advanced research, Sikorsky Aircraft.

Results to date, he says, indicate that the helicopter can be designed to achieve speeds of 175 kt. to 200 kt. by means which include negative blade twist, increased rotor solidity, use of auxiliary forward propulsion. Extension of speed to 300 kt. may be possible with the use of fixed wings to unload the rotor.

Specific Weights

Regarding powerplant considerations, said Michel, turbines presently employed have specific weights of as little as .25 lb./hp., compared with 1 lb./hp. for reciprocating engines. Specific fuel consumption is constantly being reduced, the present value of .6 lb./hp./hr. will shortly drop to about .4 lb./hp./hr., equaling or bettering reciprocating engines.

Federal Aviation Agency statistics show 700 helicopters and 10 autogyros registered with the agency. There are 156 commercial helicopter operators in the U. S. and Canada today using 631 rotorcraft, an increase of 10% in operators and 11% in helicopters since 1958, according to the Helicopter Council of the Aerospace Industries Assn.

There are 264 helistops and heliports located in the U. S. (of which 23* are ground level and 27 are rooftop). In addition there are approximately 100 helicopter platforms on movable and stationary oil rigs in the Gulf of Mexico where the helicopter is an accepted tool of that industry. The Civil Aeronautics Board has on file 76 applications for scheduled helicopter service.

The helicopter passenger lines—New York Airways, Chicago Helicopter Airways and Los Angeles Airways—recently ordered turbine-powered craft for delivery in 1961. The largest piston helicopter today can carry 15 passengers at a cost of about 20 cents per passenger mile. The turbines and other VTOL aircraft will handle a minimum of 25 passengers at half this cost.

Rotorcraft on order include five twin-engine Sikorsky S-61s for Los Angeles Airways and six for Chicago Helicopter Airways. New York Airways has ordered 10 twin-turbine Vertol 107s of which five will be delivered in the spring of 1961 and the remaining five by the end of 1963. Fleet and traffic figures for the three lines for 1959 are as follows:

• **New York Airways.** Currently owns five Vertol 44Bs and one Bell 47 and last year carried 124,199 revenue passengers 2,397,000 revenue passenger miles. Load factor was 50.1%. Mail carried totaled 18,095 ton miles, express 13,788

ton miles freight, 7,327 ton miles Total revenue ton miles was 268,295 Per cent of revenue to available ton miles 49.2%

● **Chicago Helicopter Airways.** Present equipment includes four Bell 47s and six Sikorsky S-58Cs Revenue passengers carried last year totaled 204,452 for 3,678,000 revenue passenger miles Load factor was 50.7% Mail carried totaled 14,435 ton miles Total revenue ton miles was 364,577 Per cent of revenue to available ton miles 42.4%

● **Los Angeles Airways.** Now owns five Sikorsky S-55s and two Sikorsky S-51s Last year revenue passengers totaled 43,351 revenue passenger miles 1,487,000 Load factor was 56.6% Mail carried totaled 54,527 ton miles, express 27,416 ton miles Total revenue ton miles was 274,088 Per cent of revenue to available ton miles 63.2%

Federal Aviation Agency recently inaugurated its own 24-hr all-weather helicopter operation in the New York area to aid in the formulation of rules and regulations governing the certification of the new turbine-powered helicopters and their crews The FAA's experimental helicopter service also will be concerned with navigation services required and data on helicopter instrument flying

FAA also is studying use of flying crane helicopters carrying passengers in detachable pods (AW Feb 15, p 43) For suburban commuters, FAA envisions a three-engine crane capable of lifting up to 40,000 lb of payload Pods considered could be designed as buses or even subway cars

Military Turbines

There are five principal military contracts for turbine-powered helicopters These are as follows

● **YHC-1B Chinook** Army has ordered five of these Vertol aircraft, with five more programed for Fiscal 1960 Initial contract was for $20 million The Chinook is a tandem rotor medium transport helicopter with a normal gross weight mission of two tons internal payload and a maximum alternate gross weight mission of eight tons external payload Top speed is specified as 152 kt, cruise speed 130 kt Powerplants will be two Lycoming YT55-L-5 free turbine engines rated at 2,200 shp each First delivery of initial order will be made in November and the last in April, 1961

● **HSS-2** Sikorsky's twin-turbine amphibious helicopter will be the Navy's first all-weather rotorcraft that can both search out and destroy enemy submarines and still achieve maximum design range First deliveries are scheduled for late 1960 It is in the weight class of a medium transport helicopter and will have nuclear depth bomb as well as conventional warfare capability Capable of single engine operation with a full load it has a maximum single engine speed of about 105 kt Production aircraft powerplants will be two General Electric T58-8s of 1,250 shp each

● **HU-1 Iroquois** Bell's turbine-powered utility helicopter exceeds initial Army requirements calling for 100 kt cruise, climb at 1,500 fpm and delivery of an 800-lb payload over a 100 naut mi radius Development of its tactical capabilities include its use in gun fire suppression on the battlefield Bell has fitted an HU-1A with a missile rack extending from each side permitting loading of six French Nord SS-11 solid-propellant remote-controlled rocket weapons Initial series of 100 production models will enter service in the spring Powerplant is a Lycoming T53-L-1 military rated at 860 shp

● **H-43B Huskie.** This Kaman helicopter features an intermeshing rotor system and servo flap rotor control In production for the Air Force, 116 H-43s have been ordered primarily as crash rescue vehicles Other features include clam-shell rear loading doors and bear paws for all surface landings On Dec 9, 1959 a production H-43B established a new world's altitude record of 30,100 ft for helicopters in the 3,850-6,614-lb weight class Huskie powerplant is a Lycoming T53 of 825 shp

● **HU2K-1 Seasprite** Kaman's single-rotor helicopter has capability as an ASW vehicle, but so far is slated by the Navy for utility Initial $13 million Navy contract called for delivery of four Seasprites in 1959 Kaman has a $14 million follow-on order and will deliver 12 more helicopters in 1960 Search and rescue is its primary mission It also will be used for long-range high-speed liaison duty with the fleet HU2K can carry 13 combat troops in bucket seats or accommodate up to four litters Powerplant is a single General Electric T58-6 rated at 1,025 shp

Other major activities and developments include

● **Sikorsky Aircraft** The twin-turbine, all-weather S-61, a 25-28 passenger airliner will make its first flight in the fall Construction is programed this year for the twin turbine S-64 flying crane, with a payload of eight tons FAA certification of the single-turbine S-62, 8-10 passenger utility aircraft is expected in early spring Production of the S-58 for both the Navy and Marines will continue through 1960 and 1961 Nearly 1,200 have been manufactured

In its long-range development Sikorsky is working on three active projects: a four-turbine crane which could carry a 40-ton payload a compound assault helicopter with a gross weight of 35,000 lb and a top speed of 250 mph, and a

BELL HU-1A IROQUOIS

convertiplane designated the S-57 which would combine the high speed of the jet airplane with the versatility of the helicopter. The engine would have a 12 bladed rotor, a gross weight of 25,000 lb and a cruising radius with payload, of 100 naut mi at 115 mph.

During 1960, in addition to the HSS-2 the S-60 Skycrane was introduced. Built by Sikorsky as a research vehicle, the crane also incorporates a 20 seat experimental passenger pod. Built in cooperation with the Navy, the crane carries cargo externally. It has a lifting capacity of five tons. Powerplants are two Pratt & Whitney R-2800 piston engines.

• **Bell Helicopter Corp.** Both HU-1A and B Iroquois (with the L5 version of the Lycoming T53 turbine) will be rolled off the assembly line in 1960. Army production contracts extend through 1961. Contracts totaling nearly $50 million were received during 1959 for production models of the Iroquois. Army H-13H reconnaissance helicopters also will be in production in 1960 and the development of a turbine-powered version of the Navy HUL will bring the total types of helicopters produced or sold to eight. Navy contract was received for two HUL-2 aircraft basically the same as the four-place utility HUL-1 (47J Ranger), but powered by an Allison YT63-A-3 turbine of 250 shp.

Commercial sales in 1959 exceeded 100 aircraft for the third consecutive year. Two models were marketed last year: the four-place Ranger and the three-place 47G-2 Trooper. The Brazilian air force has ordered 12 of the latter for a contract total of $562,556. HU-1B should be certificated during 1960. Bell also is preparing proposals to the Army for multi-engine, turbine powered transport versions of its XV-3 tilting rotor type convertiplane.

• **Vertol Aircraft Corp.** Company will be operated as a division of Boeing Airplane Co. effective Mar. 31, 1960. This will mark Boeing's entry into the short haul and commuter type market to supplement its long range jet transport capability. In addition to the YHC-1B Chinook order, the Army also will utilize three YHC-1As powered by two General Electric T58-6 engines of 1,025 shp each. The Vertol 107, production version of the YHC-1A, of which 10 have been ordered by New York Airways, will be powered by two General Electric T58-8 turbines. Airline may retrofit the 107 with a third engine if needed for all-weather operation.

Two Vertol 44s have been ordered by the Royal Canadian Air Force, which now has three V-44s and 15 H-21s.

The 25-passenger Vertol 107 is expected to cruise at speeds above 150 mph.

• **Kaman Aircraft Corp.** In addition to its Huskie and Seasprite production, Kaman has in an advanced construction phase its K-16B, an S-VTOL tilt wing aircraft that utilizes a modified Grumman Goose fuselage, a tilt wing, deflected slip stream and propulsive rotor. Powerplants are two General Electric T58-GE2A engines. Tether tests are scheduled for early March, followed by full-scale tests at NASA's Ames Laboratory.

Kaman also is the American licensee for the Fairey Rotodyne, with rights to manufacture, sell and service the 70-passenger VTOL aircraft. New York Airways has ordered five Rotodynes direct from the British, with an option for 10 more, for 1964 operations. Prototype is powered by two 3,000 shp Napier Eland turboprops and Fairey blade-tip pressure jets. Production versions will have Rolls-Royce Tynes. Kaman employes now number 3,000.

• **Hiller Aircraft Corp.** Company's 1959 sales reached high of $16 million-plus, a 23% increase over 1958. The H-23 Raven, for the Army, received military certification for 1,000-hr. overhaul life on all components. Three-place H-23 has been produced for the Army since 1957. 150 Ravens are used exclusively for primary training at Camp Wolters, Tex. Commercially, first deliveries of the three-place 305 hp 12E were begun in May, 1959. Certified gross weight of the 12E will be increased from 2,700 to 2,750 lb. and prototypes of a four-place version will fly in 1960, plus a turbine-powered version of the H-23D and a completely new turbine helicopter.

Tip propulsion work continues with crane type helicopter designs. First deliveries of the YROE-1 rotorcycle evaluation aircraft were made to the Marines for field testing. Ten rotorcycles were built by Saunders-Roe, Ltd., England, under agreement with Hiller. Remaining five will be used for demonstrations.

• **Gyrodyne Co. of America.** DSN-1 drone helicopter prototype, developed by the company in line with its management of the DASH (destroyer anti-submarine helicopter) weapon system, will carry a homing torpedo. Company also has Navy contract for the DSN-2 which will carry different weapon in different configuration. Prototype powerplant is a Porsche GP-702/2 used in the YRON-1 rotorcycle which was being evaluated by the Marine Corps.

Among companies with major interests outside the helicopter field, Cessna has invested more than $3.5 million in its rotorcraft program. Its all-metal, four place CH-1C helicopter, a much modified derivative of the military YH-41 was designed for reconnaissance observation, personnel transportation and as a pilot and instrument trainer. It is currently being demonstrated in the instrument trainer configuration. Ten of its earlier YH-41s

TYPICAL OF FOREIGN SALES RACE: SIKORSKY S-62 IN INDIA

were delivered to the Army between August 1957, and January, 1958.

Raytheon Co. received in 1959 a $90,000 study contract from Wright Air Development Center for its proposed radio-powered unmanned helicopter, designed to serve as a flying platform for surveillance radar or extended range communications. Platform would be designed to hover on microwave energy beamed to its antenna from the ground.

Omega Aircraft Corp., New Bedford, Mass., turned out its first production BS-12D twin-engine cargo passenger helicopter last year. Okanagan Helicopters, Ltd., has ordered three of these models. Powerplants are two 310 hp. Lycomings. Company is designing a triple turbine version, using Allison 163s, which will raise payload from 1,000 lb. to 2,500 lb.

Bensen Aircraft Corp. (Raleigh, N. C.) B-9 Little Zipster, one man helicopter, will sell for $6,995 when type certificated by FAA. Gross weight is 700 lb., useful load 250 lb. and cruise speed 60 mph. Endurance is 2 hr. and range 100 mi. Rotor diameter is 22 ft. Mercury Mk. 75 modified outboard engine delivers 60 hp.

Brantly Helicopter Corp.'s B-2 two-place rotorcraft has dual controls, is powered by a Lycoming VO-360-A1A of 180 hp. Weight empty is 980 lb., maximum gross weight is 1,600 lb. Still-air range is 300 mi. Top speed, sea level, is 100 mph. Helicopter, designed for business, also is being evaluated by both the Army and Navy. Cost is $19,950.

During 1959, Republic Aviation Corp.'s Helicopter Division sold 15 Alouette II helicopters, the only turbine rotorcraft licensed to fly in the U. S. and Canada. Designed in France by Sud Aviation and marketed here by Republic, new production Alouettes will be equipped with an Artouste IIC 480 shp. engine with overhaul period of 750 hr. Alouette has flown to 36,501 ft., will carry a 2,000 lb. payload. Cruise speed at 10,000 ft. is 105 mph.

Development plan for an operational supersonic VTOL fighter probably will be completed and put into effect by Air Force for the Tactical Air Command before July 1. Design entries are expected from Northrop, Convair, Bell, McDonnell and Republic.

Research and development activity in the VTOL area includes:

• **General Electric's Flight Propulsion Division** is developing a turbine powered ducted fan propulsion system. Powerplant will be one of the group developed at the General Electric Small Aircraft Engine Department.

• **Piasecki VZ-8P.** Improvement in handling characteristics of the U. S. Army flying testbed was provided by installing 425 shp. Turbomeca Artouste IIB turbine to replace the pair of 180 hp. Lycoming piston engines. Number two VZ-8P, proposed by Piasecki, would have two turbines.

• **Doak VZ-4DA.** This Army research vehicle has made successful vertical takeoffs, conversions to forward flight and return. Two wing-tip ducted fans are driven from a single Lycoming T53 turbine mounted in the fuselage. Conversions from horizontal to hovering flight have been made at pressure altitudes from 3,000-6,000 ft.

• **Bell XV-3.** Bell's tilt-rotor convertiplane last year completed its first gear shift in flight and has made numerous full conversions above 10,000 ft. XV-3 is now being tested by NASA at Ames Research Center, Calif. Bell, Air Force and NASA pilots last year logged more than 60 full conversions and over 25 in-flight gear shifts in this aircraft.

SIKORSKY S-57 CONVERTIPLANE MODEL

SIKORSKY S-60 FLYING CRANE AS MINESWEEPER

• **Ryan VZ-3RY.** Company's Vertiplane, powered by Lycoming T53, aimed at producing lift through deflected slipstream principle. Test program was interrupted by landing accident a year ago and the airplane was destroyed in a crash early this year. Ryan's new Vertifan combines features of both helicopters and pure jets. Ryan is working on the Vertifan under an Air Force preliminary design contract. Company's third VTOL, the X-13 Vertijet powered by Rolls-Royce Avon, has made over 125 flights. Company had proposals for a tactical version of the X-13, none of which reached a hardware stage.

• **Vertol Model 76.** Company's Army VZ-2 became the first tilt-wing research aircraft to successfully complete conversion flights during 1958. Aircraft is currently being tested by NASA at Langley AFB, Va.

• **Gyrodyne YRON-1.** Navy has ordered a total of five rotorcycles for evaluation, three of these will be evaluated by the Marines. Payload of the one man helicopter is 250 lb.; vehicle is being considered for combat use in reconnaissance, courier, observation and limited logistic support operations.

• **Hiller X-18.** Tilt-wing airplane built for USAF is being flight-tested at Edwards AFB as a conventional aircraft with wing-engine combination locked in horizontal position. Tests will be continued until enough data is gathered to permit vertical flight tests. In these, planned for early 1960, the aircraft will be flown to 15,000 ft. after taking off as fixed-wing aircraft. Its wing will be rotated for vertical flight after reaching altitude. In later tests it will take off vertically.

During the past year the Curtiss-Wright Army-sponsored test vehicle VZ-7AP made its initial flights. A four-propeller configuration, the research vehicle is powered by a Turbomeca Artouste II gas turbine manufactured in the U. S. by Continental Aircraft & Engine Co. Configuration was designed to requirements calling for a quarter-ton of freight or cargo or four person payload, a speed of 50 mph. and a 30 min. flight duration.

Work also continues on the Lockheed CL-379 VTOL turbojet which the company has proposed to the Army, powered by Lycoming T53s of about 1,000 shp. each. Thrust augmentation for vertical takeoff by means of jet ejectors is being studied by Lockheed. Ejector principle was chosen as effective means of providing vertical thrust without overpowering the aircraft for cruise requirements.

Vanguard Air & Marine Corp., Paoli, Pa., has scheduled its proposed four-place Model 8 for entry in the business plane market in 1962. Construction of the fan wing prototype is under way. This would be Vanguard's commercial version of its two-place 2C VTOL now at NASA's Ames Laboratory for full scale wind tunnel tests. The 2C uses fans mounted in the wings. The Model 8 will be powered by twin 250 hp. Lycoming O-540-A1As supercharged to 380 hp.

Autogiro development in North America includes:

• **Umbaugh 18.** This rotary wing aircraft will be produced by Fairchild Engine & Airplane Corp. on a contract basis for Umbaugh Aircraft Corp. Sales price is $9,955. Tooling is now under way. A three-bladed rotor provides lift, forward motion is obtained by a pusher propeller driven by a 180 hp. Lycoming engine. Prototype is now being tested at Hagerstown, Md. The aircraft is yet to be certificated by FAA.

• **Avian 2/180 Gyroplane** is undergoing ground trials in Ontario, Canada. It is designed to cruise at 150 mph. at 75% power. Powerplant is a 180-hp. Lycoming which drives a ducted pusher propeller at the tail. All steel rotor is unpowered in cruise flight. Jump-starts are made by a tip-drive technique using compressed air from a bottle that is charged automatically during forward flight. The aircraft seats two in tandem. Fuselage skin is reinforced glass fiber.

Interest in air cushion and ground cushion vehicles, with prime considerations centering on future military application, was strong during 1959. Bell Helicopter developed an air scooter capable of lifting three persons 2.5 in. off the ground and traveling at speeds up to 25 mph. This vehicle is powered by a Zundapp 14 hp., two cycle motorcycle engine turning a two-blade wood fan. Company research will continue through 1960 and possibly military research and development funds will be solicited.

First military contract for a plenum chamber ground cushion machine was awarded by the Marine Corps to Spacetronics Inc., of Washington. The 30 ft. x 24 ft. long vehicle will carry eight men at approximately 100 mph. and will be powered by a 270-hp. gasoline-fueled industrial engine. The barge-like machine will weigh 15,000 lb. empty. Payload will be about 40,000 lb.

Piper's new light twin Aztec (below) flies in formation with the 1960 model Apache.

Business Flying

CESSNA 210

Optimism Keys Business Flying Outlook

By Erwin J. Bulban

Business flying entered the new decade moving at a pace that promises to shatter the spectacular records it achieved in the past 10 years and result in an explosive growth in this country's aircraft population within the next 10 to 15 years.

From 1950 through 1959, the number of business and utility aircraft sold more than doubled and the total sales dollar volume increased six times as the airplanes became larger and more complex. It is interesting to note that one manufacturer—considered the smaller of the "Big Three" in dollar volume—last year recorded more dollar volume business than the entire business aircraft industry attained only 10 years ago.

In the 10-15 years ahead, the business and utility aircraft population in the United States is conservatively expected to jump from today's 70,000 active planes to approximately 120,000 units.

Total flying hours of this general aviation fleet are expected to go to more than 20 million annually compared with current 12.3 million hr.-plus.

The industry set unit delivery and dollar volume marks again last year with deliveries of 7,689 airplanes having a factory billing price total of $129.8 million (see detailed figures, table, p. 259), an increase of 20% in number of units over the previous year when factory billings totaled approximately $101.5 million. At retail levels, this meant that in 1959, some $170 million was spent on the industry's products, an increase of $35 million over 1958.

Manufacturers last year surpassed every 1958 monthly figure in unit delivery and total dollar volume. Of the

BEECH MODEL 33 DEBONAIR

U. S. Business & Utility Aircraft Shipments—1959

(Number of Units, Builders' Net Billing—thousands of dollars)

Make & Model	January	February	March	April	May	June	July	August	September	October	November	December	Totals
Aero Design 680	3	5	5	8	4	2	7	0	2	7	8	5	60
680E	2	5	1	5	3	4	4	4	2	4	5	3	52
560E	4	5	4	3	5	3	5	1	0	4	7	3	32
720	0	0	1	0	0	1	1	1	1	0	1	0	6
	$838	$742	$494	$883	$494	$810	$1 253	$974	$886	$990	$1 081	$615	$13 026
Beech G18S Super	3	5	7	9	7	5	5	3	6	8	10	5	88
33 Debonair	5	0	0	3	5	0	5	0	3	0	13	13	85
35 Bonanza	28	32	44	40	38	40	43	41	42	14	36	36	460
50 Twin-Bonanza	4	2	7	8	5	6	6	5	4	5	9	3	66
95 Travel Air	8	5	13	13	13	13	18	13	12	12	13	13	148
Mentor	5	8	28	13	0	14	0	46	5	0	0	0	91
	$1 773	$1 916	$3 424	$3 840	$2 738	$3 121	$2 970	$4 113	$2 000	$1 479	$4 724	$2 340	$35 701
Callair A6	0	5	1	2	3	5	7	2	0	3	0	3	26
A9	1	3	2	2	3	7	0	5	5	1	0	0	17
	$36	$63	$33	$32	$23	$123	$40	$13	$5	$5	$0	$6	$364
Cessna 150	69	56	65	79	53	75	48	63	39	99	38	26	689
172	60	39	55	56	53	86	43	41	15	80	88	58	674
175	114	87	51	39	60	49	28	43	24	20	110	105	727
180	22	23	23	22	80	33	35	22	10	12	7	23	258
182	88	87	82	88	78	74	83	12	36	21	14	113	774
210	0	0	0	0	0	0	0	0	0	0	0	43	43
310C	23	24	20	27	26	23	15	15	22	10	10	8	240
L-19¹	0	5	0	12	0	10	0	0	0	0	5	0	24
	$4 679	$3 760	$4 261	$4 451	$4 346	$4 000	$3 056	$3 113	$2,970	$4 174	$2 271	$4 834	$45 703
Champion 7EC	4	7	1	3	2	4	5	3	1	1	5	2	38
7FC	5	10	0	7	11	5	7	12	4	3	0	5	51
7GC	15	4	15	13	11	10	15	2	13	5	5	5	112
7GCA	5	0	0	0	0	0	0	0	0	0	2	0	2
7HC	0	3	0	5	0	0	3	5	4	0	3	0	38
	$123	$107	$127	$125	$183	$128	$106	$134	$132	$125	$134	$123	$1 521
Colonial C-2 Skimmer	1	1	3	3	4	3	2	N R.	N R.	N R	N R	N R.	17
	$24	$10	$66	$72	$74	$72	$48	N R	N R	N R	N R	N R.	$317
Helio H-391B	2	0	0	3	1	2	N R	N R	N R.	N R	N R	N R.	7
H-395	0	3	2	0	0	0	N R	N R	N R	N R	N R	N R.	0
	$82	$159	$67	$0	$40	$82	N R	N R	N R	N R.	N R.	N R	$379
Mooney Mk 20	17	13	28	15	14	18	22	15	14	13	7	5	152
	$194	$140	$321	$194	$161	$307	$364	$196	$172	$118	$81	$58	$2 091
Piper PA-18, PA-18-A	38	84	38	66	36	46	25	39	26	20	38	32	478
PA-22 Tri-Pacer	37	49	76	42	60	64	61	42	28	70	56	79	679
PA-23 Apache	26	30	31	22	47	33	33	28	11	18	17	14	311
PA-24 Comanche	69	61	80	68	109	112	88	75	40	53	104	61	965
PA-25 Pawnee	0	0	0	0	0	0	0	0	7	22	23	21	73
	$2 380	$2 879	$3 063	$2 574	$3 840	$3 434	$2 436	$2 460	$1 452	$2 234	$3 063	$2 610	$33 134
Totals (Aircraft)	640	691	715	701	691	726	680	601	385	384	656	734	7 633
Totals (Net Billing Price)	$9 848	$8 779	$12 438	$11 580	$11 977	$11 581	$10 434	$11 511	$7 925	$8 151	$11 340	$11 309	$129 878

¹ Military models, exported. Since sales not made through U. S. military services, they are considered civil transactions.
N.R.—Not reported.

1959 deliveries, the breakdown shows 996 twin-engine business planes were delivered. There were 6,059 aircraft seating four or more persons and 1,630 of one-to-three places

In flying time, the nation's business fleet accounted for 6 million hr last year, approximately 50% more time than that estimated as spent aloft by scheduled U S domestic airliners

Big Three

Major manufacturers showed a healthy jump in commercial operations in Fiscal 1959

• Beech Aircraft Corp. recorded total commercial sales of $37,914,444, an 18% increase over the previous fiscal year, with export sales totaling $7 8 million, a 70% increase over Fiscal 1958. The company started its Fiscal 1960 year with a commercial plane backlog five times greater than at the same time a year previously. This year it expects to develop a ratio of commercial business to military business of 50-50, hopes to forge ahead to a 60 40 ratio in 1961. Plans call for increasing pro

BEECH SHOWS 1960 LINE ON WEST COAST

duction of business planes by approximately 50% over last year.

• **Cessna Aircraft Co.** noted commercial plane sales up 22% in Fiscal 1959 over the previous similar period, for a new high of $46,622,838, with the company accounting for approximately 47% of the total units sold by the industry and 36% of its dollar volume. Business airplane deliveries were up 25% over Fiscal 1958.

• **Piper Aircraft Corp.** last year sold a total of 2,530 units for $33,134,000, accounting for about 33% of total industry units and 25.5% of the industry dollar volume. This also compares with the 2,162 units the company sold for $26,548,000 in 1958. Piper's 1959 totals include 325 export units sold for $3 million. For 1960 Piper predicts sales of 3,100 units totaling $45 million. Company also forecasts a total industry market of $265 million for 1965, of which it has set a goal of 45%, or about $119 million.

Industry apparently expects to break 1959's record by a good margin. One high-level spokesman for one of the top manufacturers says that he believes dollar volumes, at retail levels, will go over the $200 million mark this year.

Predictions

Underlining the bare statistics are these statements by key figures:

• **Dwane L. Wallace,** president, Cessna Aircraft Co.: "In the past five years Cessna's business has increased 112%. I believe we can double our business in the next five years and double it again in the following five years."

• **E. R. Quesada,** administrator, Federal Aviation Agency: "More and more comparatively small firms are discovering that the airplane gives them a competitive edge. Before long the company without one will find itself out of the running."

• **Wyman L. Henry,** vice president-marketing, Beech Aircraft Corp.: "The business aviation industry is growing so fast there are not enough people in our sales organization, or that of any commercial aircraft manufacturer, to properly cover the market."

The industry is aware that this decade's major problem will not be one of merely counting the profits. It promises to be a decade of considerable turbulence in the management and technical senses.

Critical 5 Years

Cessna management freely admits—and their sentiments are echoed by their competitors—that the next five years could be the most critical in its history. The reason: the industry is growing so fast and the market has never before been so open so that positions in the industry will be in a fairly fluid state until there is a settling down period. During this fluid state, each company must make the moves that will determine its final position in years to come.

Management will continue to maintain the decision-making process, but this will become more and more reliant upon prior preparation by specialists—market analysts, product research teams, planning boards, who will attempt to develop long-range programs to guide the company. A five-year plan may be developed, for example, covering new products, share-of-the-market requirements, distribution, among other things.

As each year passes company management will be able to gage progress by how it is matching with the plan. Sales may exceed the initial goal set, then the goal would be revised upward for the next five years.

Decisions on new models are also more critical than ever before; not only does a wrong move cost considerably more than before, but the competition profits to a greater extent because of time lost and funds diverted that might have been spent profitably to promote a current line—in some cases, just a little greater expenditure would have been sufficient to develop a "weak sister" into a long-time moneymaker.

Traditional, market "boundaries," that previously had been more or less

AC Presents the Art Carney Show, NBC-TV, April 8.

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observed by the manufacturers—each cultivating a particular segment—have crumbled and each manufacturer has developed and is developing further products that clearly are in competition with those of the rest of the industry.

Cessna has developed a line that encompasses both the lower price line that had long been Piper's heavy area and the medium-price portions of Beech Aircraft's line. Piper in turn has entered into direct competition with Cessna Aircraft. And Beech has decided to expand its line considerably in both directions going further into the lower-price field, beyond the Debonair, and higher in the upper class market to the $350,000 bracket. Indications are that the company intends eventually to have a line competitive with most Piper and Cessna models.

This broad model line development, plus increased production plans, can only be successful if the companies in-

CESSNA SKYLANE

BEECH MODEL 65 QUEEN AIR

BELLANCA 260

volved greatly expand their distribution outlets Cessna has made considerable progress in this direction, in 1956 it had approximately 175 retail outlets in the U S—now it has 305 and is still expanding this program Beech also has stated that it plans to double its current 60 dealerships in this country by the end of the year

Actually, indications are that the supply of good airplane salesmen is behind the demand and the same is true of new dealer prospects The trend has been toward converting personnel and dealers from one line to another, though this supply is limited—canvassing of other industries, particularly automobile dealer organizations, is proceeding on a larger scale

Auto Experience

Ex automobile salesmen are turning up with increasing frequency at the country's airports

Distributors and dealers are also investing heavily in the brick-and-mortar and tools in addition to an enlarged sales staff that it takes to get their share of the increased business that is available and coming in the near future, and also to counter hard-driving competitors

Complete and accurate tallies of expansion programs completed in the past year are difficult to come by but a check on Piper activities shows that a dozen facilities reporting have spent approximately $2 3 million in new or modernized plants, with five of these stating their expenditures are in six figures

Manufacturers are increasingly active in aiding dealers and distributors in modernization programs—at least one company has set up a styling team to advise on how to achieve maximum benefit from refurbishing, providing hints on how to get maximum benefits at minimum costs

Factory Progroms

Also, all the manufacturers are expanding factory training programs for service men—a Beech spokesman noted that he expects such activity to increase greatly in scope over the next 10 years, with the factory providing guidance in training outlet personnel from mechanics to secretaries

With bigger stakes on the line the manufacturers will be riding closer rein on their distributors and dealers, scrutinizing their operations closer than ever before, demanding higher standards and making it plainer that those who feel that they just want to make a living would be happier trying something else These would be replaced with more energetic operators.

The active business fleet now comprises some 30,000 airplanes out of a grand total of approximately 70,000

airplanes in the general aviation category, which includes all privately owned and operated civil planes other than scheduled and nonscheduled airliners. The six million hours now being logged annually by the business pilots represent a 50% higher total than the time spent aloft by all of the domestic scheduled airlines combined.

Annual hours per business airplane are going up constantly due to improved aircraft, equipment and increased experience. It is estimated that business airplanes are averaging 500 hr. per year—or approximately 75,000 mi. annually.

This averages out to six times the mileage that an airborne businessman can cover compared with his contemporary who still seeks his business via surface transportation.

The customer now has the largest selection of aircraft to choose from in any time in history and they are tailored to suit the purpose. Lacking yet are turbine-powered airplanes in the light twin class, indications are that manufacturers will tend to make a transition from piston to turboprop before taking on the turbojet in any numbers. Only one airplane of this latter category is available in the four-place class—the Beech Morane-Saulnier MS 760, which has had comparatively little acceptance in this country.

With an eye toward the several lightweight turboprop engines that are being developed, notably the U. S. Allison 250 and Boeing series, manufacturers are already tailoring several of their newer twin airframes eventually to take these engines with minimum modification.

Among the most likely candidates for this form of power are the Aero Design Alti-Cruiser, which already features cabin pressurization, and the new Beech 65 Queen Air, which has provision for a pressurized cabin. In the light twin category, the Beech Travel Air looks like it has strong potential for the smaller turboprops when they are considered ready for commercial use.

Turbine Plans

Meantime, the larger multi-engine class definitely has swung to the turboprop and turbojet powerplant. Indications are that this market potential has been hurt by the ready availability of comparatively low-cost Convairliners surplus to airline requirements with advent of later aircraft. Still on the horizon is the further effect that even larger disposals of airline fleet equipment will have, when the carriers turn toward the next generation of lighter short-haul, two- three- and four-engine turbojets, which should be making themselves felt in the 1963-1965 period.

Status report on the turbine-powered larger airplanes—the Fairchild F-27,

Lockheed Jetstar and Grumman Gulfstream indicates that although these airplanes are hardly being absorbed into corporate fleets in considerable quantities, they are showing up, or planned for, in noticeable quantities.

• **Fairchild F-27,** powered by twin Rolls-Royce Dart turboprops. Fairchild has delivered 18 airplanes out of a total of 24 on firm order by corporate operators, the company says additional sales are being negotiated. The 18 airplanes delivered so far have accumulated approximately 7,000 flying hours in a little over a year's operation.

Noland Co.'s airplane, for example, has some 1,000 hr. on it. Several others have over 800 hr. One original corporate F-27 operator has ordered two additional airplanes and two other present operators have each ordered an additional airplane.

• **Lockheed Jetstar** four-jet transport. Lockheed reports it has 31 airplanes sold, 20 with definitive contracts and the other 11 with initial deposits. The company notes it has allocated an additional 30 positions on its production line at Marietta, Ga. It expects to make the initial delivery to a private buyer late this year.

It reports sales of five Jetstars in three foreign countries and is currently negotiating the sale of twelve other Jetstars in five countries.

Three production Jetstar fuselages have been lifted from their assembly jigs and wings and empennages are now being assembled.

JT12 Configuration

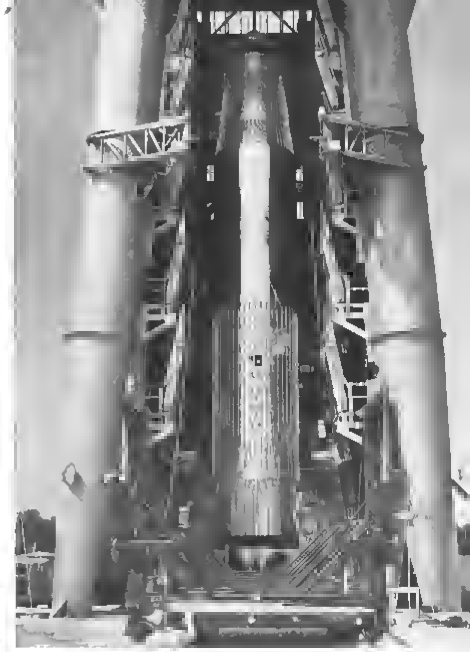
One of the two original prototypes, scheduled to fly by this month has been modified to production configuration with four Pratt & Whitney Aircraft JT12 turbojets, dual wheel landing gear, high lift wing leading edges, thrust reversers and external slipper tanks. The first production Jetstar is scheduled to start flight tests in July.

• **Grumman Gulfstream,** powered by two Rolls-Royce Dart turboprops. Company to date has 47 orders for the 10-12 place executive airplane (in high density configuration it will carry 19 passengers). Deliveries to date number 24, of which 28 were delivered in 1959. Purchasers have included Sinclair Oil, Continental Can, National Distillers, General Foods, General Electric, etc. Grumman will produce 36 Gulfstreams in 1960 at the rate of three a month, by Dec. 31 Grumman expects to have a total of 64 aircraft either committed or sold.

Basic cost of the Gulfstream is $896,000. With distributors adding an average of $150,000 worth of electronics, communication equipment, interior design, radar, etc., average aircraft cost to customer runs about $1,046,000.

French Dassault Mirage III Mach 2 interceptor with auxiliary rocket powerplant.

Foreign



DE HAVILLAND BLUE STREAK IRBM

● BRITAIN

Britain Slims Industry for Leaner Days

By John Tunstall

London—Apparent smoothness of the recent regrouping operation and the confident new look appearing on the face of Britain's aircraft industry only masks the critical situation still facing the industry, even assuming massive government support

The industry and the government have taken high aim: nothing less than a 20% share of the world's aircraft business. But there are reasons to question not only ability to reach that target, but prospects of even maintaining last year's per cent share

The problems are legion. In spite of many sound world market surveys, there are still projects to be scrapped to bring economic logic into the industry. Altogether there are at least 28 military and 17 civil airplanes under development in Britain. Eleven civil projects are in design stage and four in semi-production. Yet if all the orders Britain received last year were for the same aircraft, even its manufacturer would still not have broken even.

Achieving a sound competitive position is not only going to take reorganization and concentration of effort, but it also will require huge government subsidies. Minister of Aviation Duncan Sandys is plainly convinced of this. He has still to inform the taxpayer of the exact size of the subsidies—and to convince him of their necessity.

Turbofan Problem

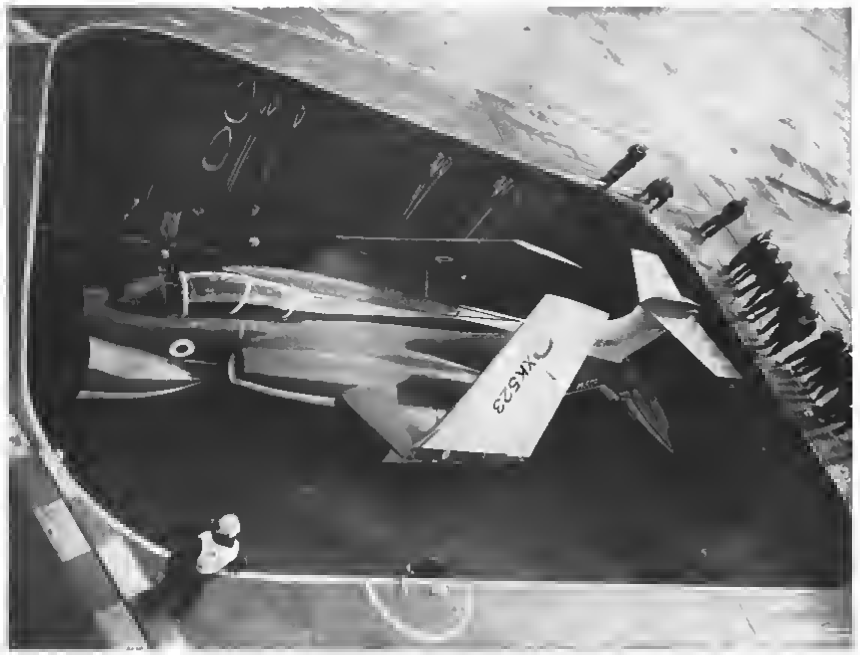
On top of the industry's airframe problems there now looms the possibility that government failure to encourage development of the turbofan engine may prove a procurement error at least as damaging as its previous abandonment of the long-range jet. There are many British technicians convinced that this engine in swept wing combination has emerged conclusively as a superior arrangement to both the turboprop and the turbojet aircraft for all but very short ranges. If this is so, then America—which has a two-year lead over Britain in the fan—for the first time has established a simultaneous lead in both engine and airframe categories.

With the engine advantage no longer in her favor, Britain is faced with the problem of selling more airplanes under less favorable conditions.

Informed speculation puts the necessary figure for government support for the industry as high as $1,200-1,500 million, spread over several years to cover defined research and production programs in the supersonic and subsonic aircraft, satellite and helicopter categories. As working capital, some of this would be recoverable but the remainder would still be a large part of the national budget.

It is generally expected that this whole issue will be made the subject of an open political debate in the House of Commons.

The industry has made its case clear. It maintains there is too much national prestige at stake for Britain to quit manufacturing over the full aircraft category spectrum. If this were not so,



BLACKBURN NA. 39 ON ELEVATOR OF HMS VICTORIOUS

aeronautics would have been a dirty word in Britain long ago. For, as she has found to her cost, there is no other engineering product with requirements so formidable, customers so fastidious, markets so shifty, competition so fierce, and profits so small. Yet an industry in which labor charges are 35% of the total cost and where 14% of its labor force is professional engineers, scientists and technologists, is well suited to Britain's economy.

Backing up its financial support, the government has promised the manufacturers fullest cooperation from all overseas government offices, embassies and attaches in the industry's sales effort.

Installation difficulties imposed by the adoption of buried engines was one of the factors delaying turbofan developments in Britain. It prevented the adaptation of existing turbojet engines because the extra diameter due to the fan could not be accommodated in the existing wing root structure. Podded construction did not present this difficulty for American engines.

One of Britain's top engine experts maintains that both Bristol and Rolls-Royce are now at least two years behind the U.S. in this engine field. The emergence of the turbofan is therefore bound to aggravate tough decisions already facing the airframe groups—basically, which aircraft to drop and which to pursue. These decisions involve situations just as delicate and even more critical than those which already have been taken in deciding who shall make the airplanes and who shall be subcontractors.

Many people think that Britain should now admit defeat in the long range jet battle with the U.S. and quit this field. Virtually all the world's airlines are committed to American long range jet airframes, and together with the availability of General Electric and Pratt & Whitney turbofan units the American position appears unassailable.

Advantages which Vickers claims for the VC 10 when it enters service five years after the Boeing are not expected to induce airlines to switch to British equipment. It is also possible that the supersonic airliner is too close to justify the unorthodoxy of this airplane over its established counterparts in the U.S.

Apprehension is also felt for the Vickers Vanguard. Its competitive status was based on turboprop economics which are now challenged, except over very short ranges, by turbofan-swept wing combinations, offering pure jet speeds for the same costs and flexibility as the turboprop.

Vickers has invested heavily in both aircraft. There is some belief that if further development of both aircraft is stopped, the government might compensate the company with working capital of around $300 million to develop the VC 11—a medium range variant of the VC 10.

U. S. Competition

Since both the short and medium range markets are less dominated by the U.S.—and are larger—a strong body of opinion in Britain believes the major part of the country's effort should be switched immediately to these range categories and engine development concentrated on the turbofan to power them.

But if Vickers drops the VC 10 and the Vanguard to concentrate on the VC 11—and the news from Weybridge makes this seem unlikely—it will bring the two major airframe groups into head on conflict. For the recently uprated DH 121, originally designed for 1,000 mi. range, can now carry its full payload up to the medium range bracket of 1,500 mi.

In January, 1960, it was known that the two groups had not got down to discussing a division of the market, and there was evidence of strong rivalry developing.

In any event there have been no overseas orders for the Vanguard since the contract with Trans-Canada Airlines was signed.

The issue of the supersonic airliner is also regarded as one of the most pressing problems facing Britain. There is widespread conviction that Britain should undertake development and production of a Mach 3 steel aircraft but in the short-to-medium range category in order to avoid a head-on clash with long range projects in the U.S. and USSR.

On the question of a British space vehicle program there appears to be wide confusion of objective. A marked absence of scientific awareness throughout the land makes the government suspicious of its councils, uncertain of its authority, and scared of the cost. With so much other worthwhile earth-bound research neglected, British scientists have been hesitant. But engineers and technologists, for whom there are no alternatives are solidly in favor of a space program.

Space Cost

E. G. Andrews, one of Britain's top rocket experts, has put the cost of a British space program based on Blue Streak and Black Knight combinations at less than $3 million for the first year, increasing to $15 million per year after five years, and continuing at that level afterward. This figure is less than half a cent per head of the population a year. It is even less than that spent advertising soap powders, Andrews calculated.

But the Advisory Council of Scientific Policy in Britain has advised the government against a British program because "the cost of venturing into space with lunar, planetary or solar probes would be too great for our resources and because we do not think that the scientific and technological return to be expected is likely to be commensurate with that cost."

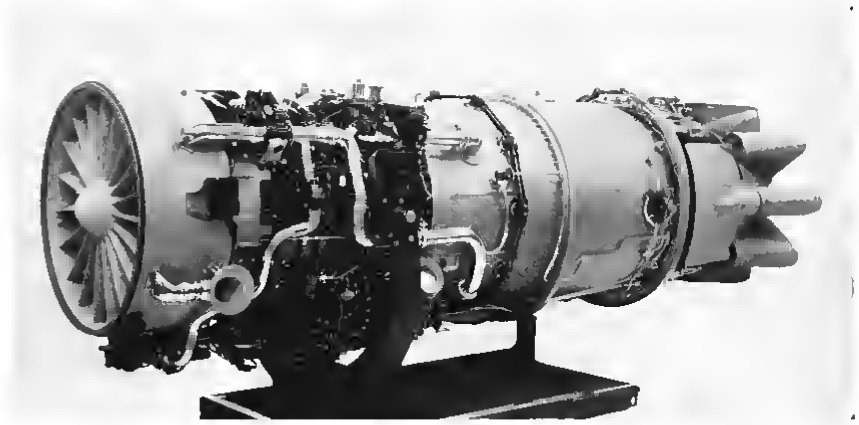
Using Blue Streak–Black Knight combinations Andrews maintained, a research platform of about a ton could be orbited at about 300 mi., and if the payload were reduced to 50 to 100 lb., lunar, planetary and solar probes could be launched with the same vehicle. Andrews pleaded that the full weight of public opinion should be urgently summoned on this issue. Engineers, he said, were hampered in what they could say by security and other restrictions, and their direct advice was suspected of bias and was ignored.

Several leading authorities told AVIATION WEEK that Britain intended to break into the general aircraft field with a new family of club and executive type aircraft including an Anson replacement. Formation of a light aircraft group is a distinct possibility to implement this program. But both Bristol and Hunting have projects within the main groups.

In the DC-3 replacement category,

HANDLEY PAGE VICTOR B.1s ON LINE

GLOSTER JAVELIN MK. 9 ALL WEATHER FIGHTER



ROLLS-ROYCE CONWAY 12 FOR BOEING 707-420

Hawker and Handley Page are still finding it tough going with the Herald and the Avro 748.

Observers report a tendency on the part of airlines to favor cheap second-hand aircraft, including the Viscount, as the best buy.

A major reorganization is also under way of Britain's 30 independent airlines and its two public corporations. This is expected to lead to major regroupings centered on five or six of the larger independents.

The first two companies most likely to merge were Hunting-Clan and Airwork.

BOW Report

Typical of current thinking is a recent report by the BOW group, an informal association of progressive—and increasingly influential—young idea men within the Conservative party.

The report called for a new licensing authority similar to the U.S. Civil Aeronautics Board. Main objective of the new agency would be the establishment of cheap fares and development of the mass market. Main criticisms of the present authority presented in the report were:

- **Lack of independent resources** to undertake its own investigations.
- **Lack of accountability** for the reasons for its decisions either to the public or to informed sections of the industry.
- **Terms of reference** favoring the corporations instead of the development of the industry.

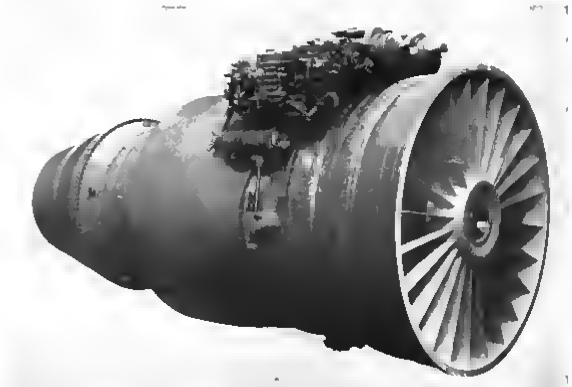
The new licensing authority should possess more public control of non-scheduled services, the report urged, and give more preference to the independents. It should encourage the independents to take over routes which the less flexible public corporations could not operate economically, or have not the incentive to promote: peak summer week-end services and the obligatory social services between Britain's offshore islands.

Parliamentary control of the authority should be exercised by a board of five part-time members who the report specially emphasized should be experts in different fields of economics, law, transport, and labor relations. On the subject of air unions, the report contended they blurred the competitive spirit.

In a move that meets some of the BOW group complaints in regard to the independents, the government plans to establish a licensing board that would break the monopoly position of BOAC and BEA and give the independent carriers a greater share in scheduled services (AW Feb. 22, p. 40).

Engine Data Lack

Besides the installation handicap in the British development of the turbofan, development of new engines in this category was not given sufficient priority. As a result there was a scarcity of transonic compressor data—transonic tip speeds obviate need for stepdown



BRISTOL BE 58 TURBOFAN

gearing between the turbine and the fan—and the solution of tricky transonic blade fabrication problems was protracted, due to the incompatibility of profile with strength.

AVIATION WEEK was told that no turbofan engine in Britain was anywhere near the development state of the adapted Pratt & Whitney and General Electric range of engines now coming into commercial service. These range from General Electric's 4,000 lb. thrust J85 conversion to the 17,000 lb. thrust Pratt & Whitney J13D.

The only comparable British engine is the Bristol Siddeley 53, which is in the 15,000 lb. class and is therefore too big for the short-medium range aircraft which it is advocated Britain should build. It is not considered an adapted engine although it uses part of the Bristol Orion turboprop rotor system. The commercial version is two years from service. Being designed from first principles as a fan engine, Bristol believes it has superior performance characteristics to any known U. S. design, particularly with respect to specific weight—thought to be possible as low as half that of its nearest competitor.

Conway's Role

Critics of the Rolls-Royce Conway and the RB.141 series of bypass engines, which all have bypass or fan ratios less than 1:1, say that the engine in effect is a super efficient turbojet rather than a turbofan. This is because the engine uses much higher gas temperatures in conjunction with air cooled blades.

When the engine started over five years ago as a 9,000 lb. turbofan it employed a small fan ratio solely to improve the propulsion efficiency. The gas temperatures were modest and no air cooling of the turbine blades was intended.

In its subsequent stretch to 16,000 lb. Rolls was forced to increase the gas temperatures to restore the specific thrust per pound of air and keep the engine girth down.

In effect, say the critics, the propulsion advantages of the bypass layout—higher propulsion efficiency due to raising the mass flow and lowering the tail pipe temperature (hence jet velocity)—tend to be cancelled out by an increase in tailpipe temperature due to the higher temperature of the cycle used.

Apart from the propulsion efficiency aspect of the engine, the question of whether aircooled blading in a commercial aircraft is justified is one of the most controversial issues in the gas turbine field since the axial versus centrifugal argument a decade ago. It splits the whole design philosophy of Britain's two engine groups. According to Bristol Siddeley, in the current state of the metallurgical art, high temperatures and aircooled blades spell short life and trouble as far as civil aircraft go.

Defenders of Britain's bypass engine, the Rolls-Royce Conway, point out that the low 0.3 bypass ratios of the R.Co.12 which powers the Boeing 707-420 series and some Douglas DC-8 versions have been raised to 0.7 in the RB.141 to power the DH.121. They maintain ratios between 0.7 and 1.0 give the best compromise between engine efficiency and pod drag.

One source reports strong efforts are under way to raise the 0.6 ratio of the R.Co.42 that will power the Vickers VC.10 to 1.0.

On the other side, Britons with the National Gas Turbine Establishment and with manufacturers do not accept performance figures for American turbofan engines and argue that actual in-flight results will be 4% under what manufacturers are quoting.

The chairman of Hawker Siddeley, Sir Roy Dobson, told AVIATION WEEK that negotiations were in progress to manufacture the DH.121 under license in the U. S. He said that the sales program for this aircraft and for the Comet were to be greatly intensified. Although world reaction to Hawker's other projects has not been overwhelming, the company is satisfied. Hawker, he said, had 15 deposits or letters of intent for the Avro 748, its DC-3 replacement, and there should be twenty Argosys in civil operation this year.

Hawker may be developing both commercial and military short take-off aircraft with the engines on the wing with ducts capable of feeding nozzles at the center of the aircraft for takeoff.

Potential market for the DH.121 is the replacement of Viscount, Convair 340 and 440 aircraft, estimated at 1,000 machines. The aircraft is expected in service in 1963. So far there are no orders beyond BEA's order for 24 and an option on 12.

Vickers VC.10 is also due to enter service in 1963 and only BOAC has ordered this aircraft—35 and an option on a further 20.

Plans for medium range and super long range variants have been announced by Vickers.

A total of five Vanguards have joined the development program of this aircraft which is due to enter service this year. No further orders have been received since the original contracts with BEA and Trans Canada airlines (20 each) were signed.

Development of Britain's blind landing system is to be expedited using Comet aircraft, under government sponsorship, AVIATION WEEK learned. The British system was originally scheduled to be fully operational on all axes in the DH.121 by 1970. There is also

a possibility that a number of military and other civil aircraft will be equipped with the automatic flare out elements and used for strictly visual landings in commercial and military operations to log reliability data.

This system is not without its critics at home. It is considered handicapped because of its need of a leader cable for azimuth reference, which denies its use universally. The cable could not be accommodated on aircraft carriers and at many airports. This situation is challenged by equipment makers who say they can improve the azimuth tolerance of ILS equipment.

Leading authorities of both airframe groups maintain emphatically that Britain should develop a Mach 3 airliner. Latest estimates show that the development and production costs for 40 aircraft would not exceed $600 million. The decision last year of the group that was set up by the Transport Aircraft Requirements Committee to investigate the possibilities of building a supersonic aircraft have been widely condemned in Britain. Experts in Britain found it impossible to explain how a committee—largely technical but including both airline and industry representatives—could recommend a light alloy Mach 1.8 airplane, based purely on manufacturing considerations, which commercially could not operate economically and totally overlook the presence of faster stainless steel projects in the U.S. and USSR.

This committee of the Ministry of Supply was sharply criticized by the BOW group report. The BOW report notes that it was this same committee that failed to predict the long range jet. The committee was dominated by the Ministry of Supply in spite of its industrial and airline members, the report maintains, and over a long period of time the committee exasperated most airline officials as well as the authors of the report. The report maintained that the consequential procurement errors which have affected the airlines, the armed forces and the industry were due to "lack of members of the right caliber and lack of leadership."

Both airframe groups are competing for the award of the supersonic contract which is widely considered probable. Strongest favorites were the Vickers group, but Hawker has been presenting a case based on its experience with the Blue Steel stand-off bomb, which is in quantity production, and is believed to be of all-steel construction and in the same speed bracket.

Heavy going in the long medium range of aircraft field is forcing Britain to take a serious look at the general aviation field including aircraft up to 20,000 lb. gross weight. The formation of a light aircraft group remains a

distinct possibility. Main obstacle appears to be one of principle. Some companies as Scottish Aviation favor building American airframes and engines under license. Others feel that there is no reason why a light aircraft group should not get down and at least develop its own airframes.

The prudence of challenging the American hold on this market is based on lower labor costs in Britain. One prominent industrial leader told AVIATION WEEK there is no reason why the aircraft industry could not achieve, with small aircraft in the U.S. home market, what the motor industry has done with small cars.

Negotiations are also believed to be in hand to make an American single-axis autopilot for light aircraft under license. Possible members of a light aircraft group would be Short Bros. & Harland, Scottish Aviation, Auster, Boulton Paul. Bristol and Huntuig in the Vickers group are known to have light piston engine projects and gas turbine executive projects in development.

The general British emphasis would be on twin-engined aircraft, according to one spokesman.

Some sources, notably Hawker, feel that business flying still has to be sold to British management. Market potential for all general aircraft categories is not put higher than 500 per year by 1965.

Missile Sales

Missile sales during the last twelve months centered on an evaluation batch of Bristol Bloodhounds for the Swedish government and an unspecified number of Short Sea Cats to the Australian government. The fifth of five Black Knight missiles was fired to a height of 500 mi. at Woomera. All five firings have been successful. The minister of aviation announced that design studies for a satellite launcher were being prepared, based on British missiles—presumably Blue Streak and Black Knight.

The Australian Malkara anti-tank missile was adopted as standard by the British Army.

Westland now has the task of developing both the Westminster and the Rotodyne but funding of these is still clouded. It was generally believed that the company would at least collect the $12 million development grant which the government agreed to give Fairey. But the company is also expecting assistance for the Westminster which is currently being funded as a private venture.

Details were also disclosed of the Dr. Barnes Wallis's proposal for a variable geometry Mach 3 airliner. Unique control features of this aircraft are the use of the wing mounted engines to provide control in yaw, roll and pitch.

DASSAULT MIRAGE IV NUCLEAR BOMB CARRIER

Civil, ASW Orders Stir French Optimism

By Robert F. Farrell

Paris—Recent international acceptance of French civil and military aircraft coupled with the explosion of France's first nuclear device have given new stimulus to the aircraft industry.

French companies admittedly are still faced with some immediate transitional problems. Big production runs on a variety of aircraft end this year, and new orders will not take up all the slack. Needs of the Algerian war still drain scarce budget funds, and the lack of a government air policy, despite the authoritarian presence of General de Gaulle, continues to hobble the industry's projects and future plans.

Despite these obstacles industry officials are entering 1960 with a good deal more confidence than they were willing to express a year ago. Reason for the renewed optimism is best explained by the following recent events:

• **Sud Aviation's** agreement with Douglas Aircraft. This arrangement assures a much brighter future for Sud's Caravelle not only in the United States but in major areas of the world where Douglas will now handle Caravelle sales. Agreement relieves Sud from heavy expenditures needed for a worldwide sales campaign, and permits the French company to concentrate on Caravelle production problems.

• **Breguet's** winning of NATO ASW competition with its twin-turboprop Atlantic design. A five-nation project for the Atlantic is slated to replace 200 NATO Lockheed P2Vs. Both Breguet and Sud Aviation will share in the production. Breguet's victory with its ASW design makes up for the company's failure a year earlier to win NATO acceptance of its lightweight fighter, the Taon.

• **Nord Aviation's** success in selling the design of its twin-turboprop cargo aircraft the C-160 Transall, to French and German defense ministries. The aircraft will be built in quantity both in France and West Germany. The Transall decision settles Nord's problem of what to do when production of its Noratlas cargo aircraft ends next year.

• **Sneema's** license agreement with United Aircraft under which the French engine company got manufacturing and sales rights for nearly all Pratt & Whitney turbojet engines. United, under the same deal, took a 10.9% interest in Sneema. Agreement came just when Sneema's own engine production has been tapering off sharply with little prospect of new business.

• **Max Holste's** 23-passenger feederliner, the twin-turboprop Super Broussard, looks like a promising seller. The company already has letters of intent on 80 aircraft. Cessna Aircraft is interested in U.S. manufacturing and sales rights and reportedly may invest up to 48% in Max Holste stock. Cessna would also turn over European manufacturing and sales rights on Cessna aircraft to Holste.

• **France's first nuclear explosion.** This event, at least for the moment, doesn't affect the industry very much. Its main effect is psychological. The explosion demonstrates French determination to establish itself as a nuclear power, at least on a par with Great Britain's nuclear posture. The aircraft industry, sooner or later, will play an important role in developing means to carry out this nuclear policy.

Lacks Firm Program

For some industry observers, the one sour note in the French situation is the confusion which still surrounds French military policy. Industry still doesn't have a clear idea of what the government expects from it. For more than a year government ministers have been working up a so-called "outline program" designed to establish a five-year construction program for the industry. Long overdue, announcement of the program is promised for spring.

Actually delay in publishing the outline program stems in part from continuation of the Algerian war. The Air Force, to meet its mission requirements in Algeria, must spend considerable portions of its funds for Algerian sorties and for purchase of surplus U.S. piston aircraft. FAF jet pilots often log more hours during the year flying T-6s in Algeria than in flying jet NATO missions in Western Europe. French

PRE-PRODUCTION DASSAULT MIRAGE IIIs

ETENDARD IV M CARRIER STRIKE FIGHTER

BREGUET ALIZE ASW AIRCRAFT

MAX HOLSTE SUPER BROUSSARD

SUD CARAVELLE JET TRANSPORT

companies have spent considerable design effort in turning out new prototypes suitable for an Algerian type war, only to have a money short government buy cheaper U S surplus aircraft Thus until the Algerian conflict comes to an end both industry and the FAF will continue to be hampered in their modernization effort

Another factor contributing to confusion over French military policy is the attitude of President Charles de Gaulle De Gaulle apparently wants France to be able to retaliate with an atomic strike force in any corner of the world where French interests are at stake This is a tall order for any aircraft industry, particularly when it is also trying to establish itself in the commercial transport field Moreover, costly contradictions between Gaullist military objectives and French financial capabilities already have appeared

Redesigned Mirage IV

Early last year, for example, Dassault at government request, re-designed its twin jet Mirage IV strike bomber to increase its payload and range In place of two Snecma Atar 9 afterburning turbojets it was decided to install two Pratt & Whitney J75s Then during budget talks last fall it was decided the bigger Mirage IV would cost too much money The U S turbojet engines already ordered, were canceled and the Mirage IV shrunk to its original size As things stand now, future FAF air power seems to be shaping up in this fashion

▪ **Tactical and all-weather interceptor** missions will be handled by the Dassault Mirage III FAF has ordered 200, with initial deliveries slated to begin this September The aircraft is powered by a single Snecma Atar 9 afterburning turbojet producing 13,200-lb thrust plus a Sepr auxiliary rocket engine of 3,300 lb thrust Mirage III 08 pre production model recently hit Mach 2.2 at 50,000 ft with this combined power system in operation

▪ **Strategic FAF missions** will be carried out either by Dassault Mirage IV strike bombers or by IRBM units This particular mission, which touches the heart of Gaullist military objectives, still has to be defined more precisely In any case, FAF won't be in a position to handle a strategic mission—with either aircraft or missiles—for another three to five years

FAF budget for 1960 contains authorization for eventual ordering of 50 Mirage IVs powered by Snecma Atar 9s Deliveries would begin in 1963 and would extend through 1964, with the full strike force operational by 1965 Mirage IV in its present version weighs about 50,000 lb and has a two-man crew Range is under 1,000 mi., which means the aircraft would fly one-way strategic missions, landing perhaps in the Near East after overflying Russian targets Single prototype of the Mirage IV is flying at present

Despite budget authorization for the 50 Mirage IVs, final decision on production hasn't been made because of the confused French IRBM situation French military men seem to be split on the Mirage IV project, some preferring to move directly into IRBM development

At present, there is no advanced French IRBM project During 1959 the government created SEREB, a combine of aircraft and engine companies, to push IRBM development Idea was for SEREB to seek out U S technical aid for the development of an IRBM which would use a French nuclear warhead The French estimated their IRBM should have a range in the 1,500-2,500 mi category and be powered by solid propellants The missile was to be ready by 1965

Last fall, however, U S companies were prohibited from working with the French on a bilateral basis For a variety of reasons Washington preferred to lend a hand developing a NATO wide project rather than enter a bilateral deal with the French The recent explosion of a French nuclear device, plus upcoming talks between Eisenhower and de Gaulle, might bring about a reversal of U S policy In any case, the French, with or without U S help, are determined to push ahead with an IRBM project After the U S rejection, the French turned to Great Britain and talks along this line are continuing

Budgetary Problem

This year, another "transition" budget has meant some reduction in FAF size Air Force budget for 1960 is $745 million, of which $380 million is to be used for R&D projects, new orders and some infrastructure Air Force section represents 22% of the over-all military budget compared with 28% five years ago FAF squadron strength has been scaled down to 35, or 660 aircraft The only new jet aircraft accepted by the FAF during 1959 was the Dassault Super Mystere, of which nearly all of the 180 ordered have been delivered New FAF orders, as usual, reflect its Algerian mission Thus the 1960 budget provides for "new" aircraft like 100 Douglas AD-4 Skyraiders and 220 North American T-28 Nomads

Despite the FAF's budgetary troubles, it is better off than the French Navy Of all three services the Navy seems to command the least amount of influence when the military budget is being put together When the Defense Ministry, during the past year, had to cut back on expenditures in order to finance the purchase of 19 additional H-34 and H-21 helicopters in the

U S it was a Navy submarine project that was scrapped Nonetheless, Navy is aiming at a modest program which by 1965 should give France a fairly efficient ASW and carrier strike force

Navy's future airpower will be based around its two light sister carriers, the 22,000 ton Clemenceau and Foch During 1959 Clemenceau began its sea trials and is slated to enter service in 1962 Foch will be available several years later Thus by 1965, the French Navy for the first time in its history, will have a modest though modern airpower unit at sea

Both carriers will use a crew of 2,500 Flight deck is 775 ft in length, 135 ft wide Canted landing deck stretches about 500 ft off from the regular flight deck Each flight deck is equipped with steam type catapults capable of launching a 15 ton aircraft every 30 sec at a speed of 112 mph Landing aid is mirror type

Navy's Etendard IV

Each carrier will have 60 aircraft For strike and interception, the Navy will use the Dassault Etendard IV M, powered by a single Snecma Atar 8 delivering 9,700 lb thrust Etendard IV M is supersonic in level flight, and has an operating range of 400 mi The Navy has ordered fifty Etendards and the 1960 budget contains funds for the purchase of turbojet engines for an additional fifty aircraft Presumably the Navy will put up the money for the extra fifty airframes in the 1961 budget First production model of the Etendard IV M is slated to roll out this year

Dassault is also experimenting with a blown wing version of the Etendard IV M for the Navy Company has replaced the Snecma Atar 8 with a Rolls-Royce Avon for the test First flight of the modified Etendard took place in December Company officials say the new formula would permit the Navy to launch the Etendard IV M at its gross weight of roughly 14,000 lb using catapults 103 ft long With wind blowing the Etendard at gross weight takes off in 1 312 ft instead of the normal 1,970 ft

Besides the Etendard, the Navy will use the Breguet Alize ASW aircraft on the two sister carriers Alize is powered by a Rolls Royce Dart and has a three man crew Navy has ordered 75 aircraft of which roughly 30 already have been delivered For its shore based ASW work, Navy will use Bregnet's Atlantic, powered by two Rolls Royce Tyne turboprops Atlantic is a midwing aircraft carrying a crew of 12 Span is 124 ft, length, 90 ft, height, 35 ft Wing area is given at 1,292 sq ft and gross weight 86 000 lb To be built in France, Germany, Belgium and Holland, the Atlantic will use considerable U S electronic equipment U S and the four NATO nations planning to use the aircraft will share in the financing, with the bulk of the money being put up by the four European partners

In addition to its two sister carriers, the Navy hopes this year to start construction on a missile-launching cruiser Final decision on this project, however, hasn't been handed down Same holds for the Navy's request for a small helicopter carrier

Major Industry Efforts

One company which hasn't been hurt by declining military orders is Sud Aviation the big state-owned airframe and helicopter company Sud does some important missile work about which little is known, but nearly three-quarters of its effort is now taken up with its twin jet Caravelle transport In fact nearly one third of the entire French industry is now involved in the Caravelle project

Sud hit a monthly Caravelle production rate of four in December four months ahead of schedule By the end of February its Caravelle orders totaled 62, with another 20 on option Sud's first U S airline sale, to United Air Lines was officially confirmed late in February United will buy 20 Caravelles and take an option on an additional 10 airplanes

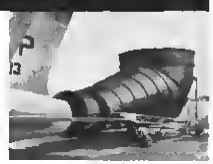
Sud's agreement with Douglas should assure that the French company will reach its breakeven point of 220 aircraft. Purchase of a single Caravelle early in January by General Electric also indicates a brighter future for the rear-engined jetliner

With GE's CJ805 23 afterfan installed Caravelle range is increased to 2000 stat mi while its cruising speed is hiked to 540 mph With both Douglas and GE pushing Caravelle sales in the U S and elsewhere Sud feels its jetliner stands a good chance of dominating the medium range jet transport market The Douglas Sud tie-up alone eliminated one Caravelle competitor Douglas' own DC-9.

Besides the Caravelle Sud's other main activity is in helicopters Sud still has sizable Alouette orders to work off, and has begun deliveries on a government order for 150 Sikorsky H 34s which it is building under license Sud's heavy prototype helicopter the tri-turbine Frelon (Hornet), still is undergoing tests

Two Frelon prototypes are flying each powered by three Turbomeca Turmo engines rated at 785 eshp Main four bladed rotor is 49 ft in diameter Frelon, designed to carry 20 passengers, is aimed at both the military and civil markets Sud, in connection with its helicopter activities, also is working with Augusta of Italy on the design of a flying crane which will be capable of

COMMERCIAL MODEL JEC 10



MILITARY MODEL JEM 8

STATIONARY TEST UNIT

handling payloads of up to 12 tons

Nord Aviation, France's second largest nationalized company, continues to work on some of the most interesting projects in the industry. Last fall, Nord's development achievements with its Griffon 2, an experimental ramjet-turbojet interceptor, won international recognition when company test pilot Andre Turcat traveled to Washington to accept the Harmon Trophy for his Mach 2.19 Griffon speed run.

Nord officials remain convinced that future transports in the speed range above Mach 2.5 will settle on a ramjet turbojet combination, such as Nord is studying with its Griffon. Turbojets installed within the ramjets, as is the case with the Griffon, would be used for low speed portions of transport flight, such as takeoff and landing, while ramjets would provide main propulsion during cruising portions of flight.

Comparative powerplant studies by Nord have convinced company officials that their ramjet turbojet system promises a 30% saving in powerplant weight. This would increase a Mach 3 transport's range by 20% or double its payload, Nord says.

Partner Sought

Nord would like to join with an American company to continue its ramjet-turbojet work. In fact, the future of Griffon studies may depend on Nord's success in finding an American partner. Nord officials will spend additional research funds on their ramjet program only if it is aimed at specific aircraft goals, not just testing goals.

Meantime, Nord intends to keep its single Griffon 2 flying despite the fact that adequate funds for this project aren't in the 1960 budget. Company also has the earlier Griffon 1 model, powered by turbojet only. It wouldn't take major modification work to add the ramjet to the Griffon 1. This would give Nord two ramjet-turbojet experimental aircraft. Then if Nord worked out an agreement with a U.S. company, it would plan to start construction of a high-speed airframe powered by a special ramjet currently under study.

This experimental aircraft would be in the Mach 3 range and in size would be "considerably larger" than the 15,000 lb. Griffon 2. Like the Griffon, a turbojet would be installed within the ramjet. Object of this experimental aircraft would be directed at civil transport applications rather than military. Nord, however, would limit its interest to technical association with its American partner. Company has no intention of getting into the manufacturing end of high-speed transport aircraft.

While top engineering interest at Nord appears to be centered on its high-speed ramjet work, the company is heavily involved in a wide range of aircraft and missile work. In fact, almost 50% of Nord's current business is in guided missiles, sold both to French and foreign military. To date Nord has produced 40,000 of its anti-tank and target missiles.

Main Nord missiles are the familiar wire guided SS 10 and SS 11 anti-tank missiles. Nord is now extending this category of missiles by developing the SS 12. Warhead on the SS 12 is nearly twice the size as that on the SS 11. Company says SS 12 range is substantially greater than the SS 11 range of roughly two miles. This probably explains why the company is offering the SS 12 either with wire guidance or radio link guidance. Latter very likely is necessary if the mission requires use of full SS 12 range.

Nord thinks its three SS missiles should just about fill the varying requirements for close-work tactical missiles of this type.

Drone Projects

Nord also is extending its target missiles into new mission territory in this case into the supersonic region. Company already has racked up considerable domestic and export success with its pulse-jet CT-10 and its turbojet CT-20. Both are subsonic target missiles. This year Nord expects to complete testing of its CT-41, a supersonic twin-ramjet target missile.

CT-41 speed range is between Mach 1.5 and 2.5. Missile weighs 5,620 lb. at launching and is recoverable. CT-41 should permit Nord to maintain its export position in the target missile field. Already a licensing arrangement has been worked out with the Hawker-Siddeley Group.

Nord's other known missile in production is the air-to-air AA 20, or 5103. Company is producing the missile in quantity, both for FAF and for several NATO nations. An air-to ground version of the 5103 also is in the works, mainly for use on the Fiat C 91 strike-fighter. Main difference is the removal of the proximity fuse from the 5103 when it is used against ground targets. Nord 5103, together with the larger and faster Matra 511, are the only French air-to-air missiles in production.

Nord's attempt to develop an anti-aircraft missile had to be dropped when France agreed to enter into the NATO wide Hawk program. Nord's anti-aircraft missile, labeled the 5301, has the same basic configuration as the 5103 air-to-air weapon. Both use jet exhaust vanes for directional control.

Production run on Nord's main aircraft effort, the twin-engine Noratlas, is nearing its windup with nearly 200 of the cargo transports already delivered. Company expects to follow on this aircraft with the Transall C 160. Latter

PROBLEMATICAL RECREATIONS 4

A man enters a bank and has a check cashed. The teller mistakes the figures and pays cents for dollars and dollars for cents. The man then pays a bill for $24.11 after which he finds he has twice as much money as the face value of the original check. What was the face value?

—National Mathematics Magazine

ANSWER TO LAST WEEK'S PROBLEM: Each voyage involves the most "restrictive" condition of the three, viz., no woman ever remains in the company of any man unless her husband is present. The least number of couples n in the first voyage is 2 which also equals x and the number of crossings is 5. If n=3, x=2, then y=11. If n=4 or 5, x=3, then y=9, and y=11, respectively. Happily however for n>5, x=4 and y=2n−1.

aircraft, designed to haul eight tons of payload 2,800 mi., will be powered by two Rolls-Royce Tyne turboprops. Nord is working on the project with three West German companies.

Initial prototype, however, is being built by Nord. Overall responsibility for direction of the project rests with Weser Flugzeubau. Nord is mainly responsible for Transall design which, in many respects, is dimensionally equivalent to the Lockheed C-130 Hercules. With the Transall, Nord will keep an important interest in cargo transport development.

Nord's other major aircraft activity is an 80% share in production of Max Holste's Super Broussard. This work is slated to get under way later this year and should help Nord over the production lag between the end of the Noratlas line and the beginning of its Transall production. Nord is also producing several hundred light aircraft for training and observation missions of the French Army.

Max Holste's Super Broussard is the most advanced of three French civil transport aircraft currently under development. Holste transport presently is flying with two Pratt & Whitney R1340 engines. Production version, slated to fly before June this year, will be powered by two Turbomeca Bastan turboprops.

Actually, Holste prefers to install two Lycoming T53s. Studies also have been made with two Bristol-Siddeley P182s. Power range offered by these three engines is from 750 to 1,000 hp. Price of the 23-passenger feederliner hasn't been fixed yet, although the Bastan-powered Super Broussard, equipped, probably will run just under $200,000. With the T53s, Holste is working with a figure of $225,000. Holste expects to use the T53 in a pressurized version of the Super Broussard, labeled the MH 262, which is slated to fly in February, 1961.

Another small French transport prototype, the Potez 840, is scheduled to fly before the end of 1960. Potez, a private company which a year ago absorbed Air Fouga, is financing the P840 out of private funds. Some industry observers are surprised to see Potez putting money into a project which is competitive with the Super Broussard. Latter project is being supported by the government. Potez, however, argues that his transport complements rather than competes with the Super Broussard.

Potez P840 is a low wing monoplane, powered by four Turbomeca Astazou turboprops. Wingspan is 63 ft., gross weight 16,755 lb. P840 is designed to carry from 16 to 24 passengers over distances between 300 to 950 mi. Astazou turboprop, just certificated, develops 470 hp. (takeoff). Fuel consumption reportedly is 278 lb./hr. Total weight of engine and propeller is 420 lb.

Potez P840 is first production aircraft to select the new Turbomeca small turboprop. SEIERA, a French company in Bordeaux, currently is installing two Astazous on a Beechcraft Travelair. Company also is installing one of the small turboprops on a Dornier Do 27.

Third French civil transport project is Bregnet's STOL blown wing 941. Prototype, the 940, has completed a wide range of ground and flight tests. Larger version, to be powered by four General Electric T 58s, currently is under construction. The 941, which will gross around 18 tons, may fly before the end of this year. Bregnet received some U.S. financial help in the 940 project, hopes to interest French and U.S. military in its larger effort.

The one French project which produced considerable popular interest, and then faded out of sight, was Snecma's VTOL Colcopter. Last August, the company's single annular wing prototype crashed and burned during a test flight. Pilot Auguste Morel managed to eject successfully from an altitude of less than 225 ft. Morel already had carried out transitional flight tests. He was descending when for a still undetermined reason insufficient throttle caused the aircraft to lose its stability. Snecma, still convinced its formula is valid, is waiting for either the French or German Defense Ministries to put up additional development funds.

French space effort still remains minimal. Last summer, the French cabinet voted $50 million for a four-year program which will include initial development of a missile carrier capable of placing a small satellite in orbit. Most of the $50 million will be used for development and improvement of French test missiles already in use such as the single stage Veronique and the three stage Monica types. French also are interested in participating in Operation Echo with NASA but lack of funds may prevent them from doing so.

NORD GRIFFON II

DASSAULT MD 415 COMMUNAUTE

CANADAIR CL-44

Canada Wants Industry Defense Share

By Robert I. Stanfield

Ottawa—Canadian aviation industry is looking to its government to formulate a tough policy that would give it increased participation in North American defense production—considered a market of enormous potential—and increased control of its own defense program.

Motivated by the sovereignty aspect—"the people must remain sovereign and independent and not be dominated by the United States"—the feeling also prevails that unless Canada has an industrial defense base behind its armed forces, unless, for instance, it can support its own aircraft flown by its own crews, "it would become a banana republic," one government official told Aviation Week.

Its industrial defense base gradually is being achieved through the U S.-Canadian production-sharing program based on military integration. During the past 12 months, increased opportunities have been opened for Canadian industry to compete on an equal footing with American firms—in price, technical competence and delivery dates—for defense production.

Production Progress

Canadian statistics point to this progress:

• **Dollar value.** During 1959 about $51 million in prime contracts and $45.3 million in subcontracts were received in Canada from the U S. (These figures do not reflect contracts for construction, petroleum products, communication services, etc., to the value of $25.1 million.)

• **Bids received.** Last year American defense contractors sent more than 1,900 invitations for bids to Canadian firms, in response to which about 1,400 tenders were submitted. Of these, 365 were successful.

• **Government underwriting.** Canadian government, during the last six months of 1959, has on a number of occasions agreed in principle to underwrite tooling and preproduction costs in order to enable Canadian firms to bid on more equal terms against U S. firms. Result: orders with an immediate value of about $3.25 million.

Political fire also is raging over the nuclear warhead of the Bomarc, of which two B bases, operated entirely by Canadians, will be situated at North Bay, Ontario, and the Mount Laurier area of Quebec. The United States controls the firing of the warhead. The RCAF feels that "for the good of Canada and the world it is better to swallow pride and let the U S. retain control—but the U.S. should not fire in Canada without Canadian agreement." Again—a delicate Canadian feeling on the matter of sovereignty.

Bright Spot

Uncertainty clouded the Canadian industry with the cancellation of the Avro CF-105 Arrow and its engine, the Iroquois, in February, 1959. Bright spot of the year was the placing of a $450 million contract for 214 Lockheed CF-104s for the RCAF. Canadair, Ltd., Montreal, will produce the airframes under licensing agreement with Lockheed. As prime contractor Canadair will subcontract to Canadian firms about 45% of production.

Of the total CF-104 aircraft, 14 trainers are being bought direct from Lockheed. Orenda, Ltd., will produce the J79 engines under agreement with General Electric. Canadair also is hoping to get a chunk of F-104 business from the Germans, Belgians and Dutch. Lockheed is placing a contract with Canadair for 66 rear fuselage and tail assemblies of the F-104G, which the Germans have ordered from Lockheed. First deliveries of the CF-104 to the RCAF, for an air division abroad as replacement of the F-86 Sabre, are scheduled for April, 1961.

Contractual Agreements

Also for the CF-104 the master fire control system (NASARR) is being produced under a reported $20 million contract by Canadian Westinghouse, under license from North American Aviation. Contractual agreements are still being negotiated for the Litton navigation system; initial systems may come from Litton, the remainder produced in Canada. Computing Devices of Canada will produce the position homing indicator (both for RCAF and German aircraft, which are nearly identical).

Other developments and major programs include:

• **Canadair aircraft.** Two new aircraft will be introduced into the RCAF in 1960. Canadair's CC-109, the twin turboprop medium transport version of the Canadair 540, of which 10 have been ordered, and the Canadair CC-106, the four-turboprop, long-range military transport version of the CL-28, of which 12 have been ordered.

• CANADA

Swing-tail version of the CL-44 also have been ordered by U S. airlines: five by Seaboard & Western, 10 by Flying Tiger Line and two by Slick Airways. Allegheny Airlines has leased a Convair 540 (a 440 converted to Napier Eland turboprops) and has ordered five more converted Convairs, with these engines, from Napier. Canadair's CL-41 jet trainer, the first all-Canadian-designed aircraft produced by this subsidiary of General Dynamics Corp., was designed privately.

Two prototypes have been built; most immediate customer possibility is the RCAF, which as yet has made no commitments. Canadair also is building wings, ailerons for the Bomarc B on subcontract from Boeing. Of Canadair's CL-28 Argus anti-submarine aircraft produced for RCAF's Maritime Command, all but five of the total order of 33 have been delivered.

• **De Havilland of Canada.** Production of the new STOL twin-engine Caribou continues, with the U S. Army ordering an additional seven of these aircraft for a total of 14 to date. In addition, 27 Otter aircraft went to the RCAF. Of the 100 Grumman Tracker CS2F aircraft ordered from de Havilland, 80 have been delivered.

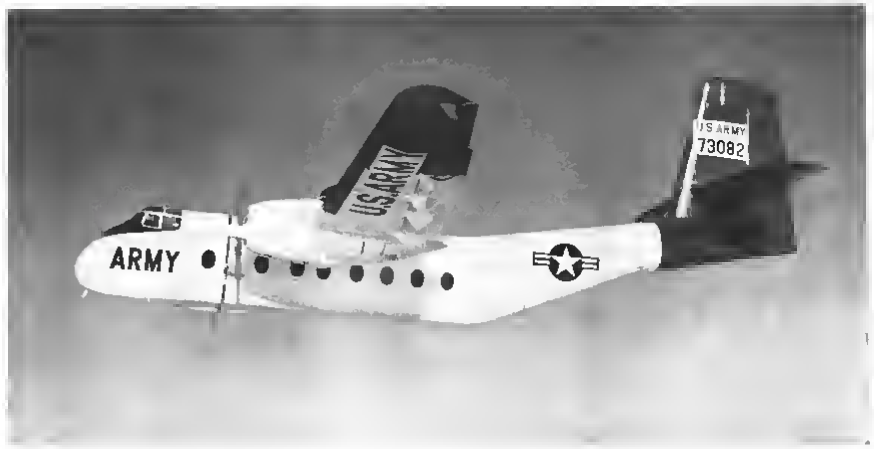
• **Canadian Pratt & Whitney.** Canada's first turboprop was produced here last year, the PT-6—a 250 lb. free turbine with takeoff rating of 500 eshp. Prototypes will be available in 1961, production engines in 1962. Engines for the Albatross and the CS2F also are being produced at the Canadian plant.

• **Repair and overhaul.** Activity was on a good level during the year, particularly with Rolls-Royce for its engines, Bristol Aeroplane Co. at Winnipeg for the CF-100, and Fairey Aviation Co. for the Navy's F2H Banshee and Neptune, etc. A Rolls-Royce licensing agreement covering all of North America is in the works between Rolls, General Motors, and the gas turbine division of Westinghouse, which would be acquired by General Motors.

Canada's air power breaks down into a fighter interceptor force, together with missiles to defend Canadian territory; a maritime air force to cooperate with the Royal Canadian Navy and NATO naval forces, and an air transport force for strategical and tactical support of land and air forces.

The RCAF's No. 1 Air Division in Europe consists of eight F-86 day fighter and four CF-100 all weather interceptor squadrons. The F-86s will be replaced by the CF-104s, similar in configuration to USAF's F-104C but with a strengthened airframe to provide increased lift for low-level operations. In Canada itself present air defense strength consists of nine CF-100 squadrons operating with Norad. All but one

CANADAIR CL-28 ASW AIRCRAFT



DE HAVILLAND AC-1 CARIBOU IN ARCTIC MARKINGS

is concentrated in the eastern section.

As a replacement for the Avro CF-100, the Canadian defense department is considering the McDonnell F-101B Voodoo interceptor. Feeling is that more manned interceptors—nuclear equipped missile carriers—are needed to meet the bomber threat. While RCAF is interested in anti-ICBM developments, it plans no major program of Canadian design. Feeling of doubt also prevails as to the military value to NATO of one air division, in light of Soviet IRBM capabilities.

Canada (the RCAF) and Germany are sharing development costs—the former to the amount of $28 million—to convert F-104Cs to F-104Gs at Lockheed, to the point that both are standardized. At this point the RCAF diverges to the strike reconnaissance version. Germany will receive the first 66 aircraft, with partial Canadian subcontracting (Canadair); the remainder will be built in Germany.

Basic transport aircraft of the RCAF is the North Star, a Canadian development of the Douglas C-54 with Rolls engines. Transport Command also includes two de Havilland Comets purchased in 1953, reconnaissance Lancasters, Dakotas, and two squadrons of Fairchild C-119s. Currently under consideration is the purchase of four Lockheed Hercules C-130Bs.

Service has five Vertol 44 and 15 H-21 helicopters.

RCAF's Maritime Air Command operates two squadrons at Greenwood, N. S., and one at Comox, B. C. Aircraft include the anti-submarine CL-28 Argus (Canadair), a derivative of the Bristol Britannia, and shorter-range Lockheed P2V-7 Neptunes.

SAGE Direction Center

The SAGE direction center at North Bay, tying in with Bomarc defense, is expected to be ready in late 1961 and operational early in 1962. Canadian concern that Canada has no control over its own defense program stems from rumbles from the United States about cutbacks, reassessment of the Bomarc program, etc., and there is anxiety apparent about the possibility of canceling Bomarc or SAGE.

Both Bomarc and SAGE sites are operated entirely by Canadians, though cost is shared with the U. S. on a one-third Canadian, two-thirds U. S. basis.

RCAF also is operating a missile test center at Cold Lake, Alberta. High-altitude rockets, being tested in the Arctic port of Churchill, Manitoba, are being built in the Winnipeg plant of the Bristol Aircraft Co. Fins for the "Black Brant" rocket are being supplied by Bristol Aircraft in Britain. Purpose of rocket is to gain high-altitude data and to test solid fuel developed by the Canadian Army.

Sweden Ties Mach 2 Interceptor Into New Early Warning System

Stockholm—Sweden's air defense system is getting a much needed modernization in a semi-automatic early warning and operational control scheme called STRIL 60.

First orders for ground-based equipment were placed recently with Marconi Wireless and Telegraph Co. of England, and deliveries are scheduled to start soon.

Major change in the system is the replacement of hand-written reporting and telephoned verbal commands by radar presentations with target followers, memory banks and remote presentations to both ground and airborne operational personnel.

Only manual link to be retained in the new system will be in the filter center. Sweden's air defense experts believe the cost of complete automation would be much too great for the country's budget.

STRIL 60 is linked with the three elements of Sweden's present air defense system—fighter aircraft, ground-to-air missiles and anti-aircraft artillery. Saab's tiny J35 Draken interceptor and two-place J32B Lansen strike fighter now are being delivered with avionic gear tying into the new system, and within a short period should be able to make target strikes under conditions of complete automation, with the pilots just along for the ride.

Transition to Missiles

Royal Swedish Air Force, traditionally a strong and independent service, is in the midst of a transition from conventional aircraft to a mixed force of missiles and manned weapons. First steps in that direction were taken early last year when the country selected the Philco-GE Sidewinder missile as primary armament for its Drakens, Lansens and Hawker Hunters.

The increased punch of the interception force will be even more effective working in the proper ground environment with the new STRIL 60 operational control system.

Drakens are being delivered in quantity now, and have undergone a couple of modifications since the original design first flew. Major change has been the addition of a full afterburner, developed by engineers of the Royal Swedish Air Board, to the Draken's Rolls-Royce RB 146 turbojet. This change has produced some fuselage area and length increase at the tail. Performance of the airplane is above the Mach 2 level, and observers of the little double-delta craft have been tremendously impressed with its low-speed performance and maneuverability near the ground and in final approach.

Saab has been working hard to get an export market for the airplane, concentrating recently on Switzerland where the high-altitude, mountainous airfields have posed tough problems for conventional airplanes. Saab's Draken has done what the Swiss expected, and its over-all performance in that country made a strong impression on the knowledgable Swiss Air Force officers.

Avionics Equipment

Major design features of the export version are a Ferranti Airpass II fire control system, and the RB 146-plus-afterburner combination standard in the J35B aircraft now going to the RSAF. For home use Draken has Swedish avionic gear, including the Saab S7 collision-course fire control system.

Ferranti system includes ground and contour mapping functions as well as terrain clearance presentations. Ground mapping is a pictorial presentation on the radar screen, which can simultaneously present dead reckoning navigational data. Contour mapping tells the pilot altitude differences in the terrain under him or in the surrounding terrain when he is flying on the deck.

Terrain clearance presentation gives the Draken low altitude capability when the pilot has no view of the ground, as in low-level night or weather missions.

Avionics equipment in the export version also includes two separate communication radios, a data link, and two navigational systems, one an electronic type and the other a dead reckoning unit.

Most of this equipment is of Swedish manufacture.

Powerplant Rating

Rolls Royce RB 146 engine is rated nominally at 13,200 lb. sea level static thrust without afterburner, while full thrust must be on the order of 20,000 lb.

For the anti-aircraft task, Sweden is still investigating different types of missiles.

Last year the first unit of Bristol Bloodhounds bought for evaluation and training began to arrive in the country. But whether or not that weapon or a development of it is the answer remains to be seen. There has been considerable Swedish interest recently in a more-advanced, automatic anti-aircraft missile system.

Space probe reaches
heights of over 500 miles—
speeds of over Mach 10—
with unprecedented reliability...

...AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant the Gamma produces a total sea-level thrust of 16 400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of only 700 lb.

The Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with a reliability that is unprecedented. For, to date, the Gamma has never failed to fire successfully.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. By combining these components in single or multi chamber layouts, thrust requirements from 500 lb up to very high figures can be met.

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Bristol Siddeley Maybach diesel engines power Britain's fastest express train—the British Railways "Bristolian." Two type MD 650 engines, developing a total of 2,200 hp, give the "Bristolian" a top speed of over 90 mph.

The Bristol Siddeley Orpheus, the world's most advanced lightweight turbojet engine, powers this Fiat G 91, NATO standard lightweight strike fighter. The Orpheus is in service in six different aircraft and is specified for eight others.

The Bristol Siddeley Proteus powers the Britannia airliner. Four Proteus give this 130 seat aeroplane a speed of over 400 mph—a range of over 5,000 miles. Britannias are in service with twelve airlines and with RAF Transport Command.

Germany Buys Technical Time With F-104

By David A. Anderton

Bonn—Overnight, West Germany appears to have bought the dual crown of technical leadership in Europe's aircraft industry and military leadership in NATO. The price was the program cost for the Lockheed F-104G Super Starfighter strike/interceptor aircraft, chosen to be the backbone of the new Luftwaffe.

Within two years, the West German aircraft industry is expected to be the strongest in Europe—technically and competitively—through its development and production of a sophisticated, modern weapon system.

By 1962 the Luftwaffe is scheduled to be the strongest single air arm in NATO, and will have a strike capability almost equal to the rest of the countries put together.

Technical Bridge

For the industry, the Super Starfighter program will serve both as a bridge and a foundation. It will bridge the gap of more than a decade of lost technology, the period after the war when Germany was out of the running in the development of airborne weapon systems. It will be the foundation for technical independence of the industry, and for its future expansion into advanced weapons development and commercial lines.

For the Luftwaffe, the F-104G will be an aircraft equal to the best flown by any NATO country, the United States not excepted.

For NATO, the addition of the Luftwaffe strength will give the alliance a tremendously increased strike capability, through the retaliatory force of several hundred tactical bombers deployed at advanced bases in Germany.

Finally, for Europe, the production program now envisaged for the Lockheed design will bring tangible financial benefits to the aircraft industries in Belgium and Holland—which will share the production of the Super Starfighter with Germany—and possibly to other countries as well. The benefits accruing to those countries will help assuage some of their fears of a rearmed and tremendously strong Germany.

Current German F-104G commitment is for a total of 660 airplanes. The final procurement plans for these airplanes, plus the estimated 300 additional ordered jointly by Belgium and Holland, are still being discussed in talks and contract negotiations. But plans now are to buy the first 96 airplanes from Lockheed and produce the rest in Europe with Germany acting as the prime contractor parceling out work to Holland and Belgium.

The Defense Ministry's choice of the F-104G has set the rebounding German aircraft industry squarely on its feet in the middle of the most important single production contract for aircraft in the free world today. Before that industry and its associated groups in Belgium and Holland have finished they will have built about 1,000 Super Starfighters, plus their General Electric J79 powerplants, North American NASARR fire-control systems and Philco-GE Sidewinder air-to-air missiles.

With the purchase of the F-104G, the German aircraft industry bought

START OF GERMANY'S NEW LUFTWAFFE—REPUBLIC F-84Fs IN SERVICE

current knowledge of development and production of four major components of a contemporary weapon system: airframe, powerplant, avionics and missile armament.

In a competitive sense, this should put the German industry ahead of any other in Europe, partly as a result of the numbers of aircraft involved, partly because the airplane is more modern—in the sense of production techniques—than any other in Europe.

Both technically and competitively, the engine industry gets a tremendous boost from the deal to build the General Electric J79 turbojet, which has considerably more design sophistication than any other European powerplant. The possible implications of the commercial J79—possibly as the aft fan CJ805-23—have not been overlooked by planners for the future.

Part and parcel of the Super Starfighter is its twin Sidewinder air-to-air missile armament, a weapon in large-scale production in the United States by General Electric and Philco, and adopted by other countries, including Sweden. West Germany's small but expanding missile manufacturers have quietly taken over in that field, also, and one of them—Bodensee Werke, a subsidiary of Perkin-Elmer Corp.—will be prime contractor for Sidewinders made for NATO countries. The initial order is for 8,000 rounds and is worth an estimated $25 million. There is no other aircraft missile activity in Europe near that level.

Current plans for the Super Starfighter's fire-control system envisage the use of North American's Autonetics Division's NASARR, possibly built under license by one or more of the European avionics firms. Here again West Germany has a strong industry with productive capacity and technical ability to handle the job.

Military Growth

Within two years, the Luftwaffe expects to field a total of 1,000 modern jet aircraft, not counting support, transport and training types. Majority of these will be the F-104G. Front-line and reserve pilots will total about 1,500 for these planes, in agreement with the NATO target figure of 1.5 pilots available per combat aircraft. Total strength of the Luftwaffe will be a planned 100,000 men working out of a complex of forward bases hardened and modernized to meet the requirements of tactical nuclear warfare or a major offensive strike against the enemy.

Between the planes assigned to NATO, and the units kept for home air defense—still a national rather than a NATO responsibility—the Federal Republic's strength in the air will probably be greater than all the rest of the NATO countries put together, in the sense of combined strike and interception capabilities.

The military build-up began when Germany officially became the 15th NATO country in May, 1955. Recruiting began, and the first shipments of foreign weapons started into the country.

Republic F-84F and RF-84F fighter-bomber and reconnaissance aircraft were assigned to tactical squadrons and the Maltese Cross of the new Luftwaffe was airborne again over Europe. North American F-86K all-weather fighters built in Italy were delivered to bolster air defense force units.

In June 1958, four F-84F fighter-bombers of the German Air Force's 31st Squadron roared into the air to join other NATO planes in the first postwar exercise of the new Luftwaffe. Four planes: the entire operational German Air Force at that time.

Now, 18 months later, the Germans have about 400 combat aircraft, the necessary pilots and reserve pilots and a total personnel strength of just under 60,000.

In another two years, the force is expected to be at its full strength of 1,000 combat airplanes and 1,500 pilots out of a total strength of 100,000 personnel.

Rebuilding Approach

In retrospect, Germany's approaches to rebuilding its twin pillars of air power—the industrial plant and the military establishment—stand out as the most logical plan conceived at a national level in years. There were two major jobs to be done: the military had to be brought up to the necessary planned strength and the industry had to be brought along a parallel path to a position of power.

The industrial build-up had started in Spain within days after the end of the war when Dornier's brilliant design staff began work on an STOL light transport, and in Germany, where Messerschmitt and Heinkel engineers designed and produced bubble cars. Before long Dornier was back near Munich, with an order for more than 400 production models of the Do 27 STOL transport for the German Army.

Messerschmitt and Heinkel got back in business building Fouga Magister jet trainers under license from France. Focke-Wulf became a producer of Italian-designed Piaggio P-149 piston-engined trainers. Flumbarger Flugzeugbau, descendant of the old Blohm und Voss flying boat outfit of World War II, became the final assembly and flight test area for the Nord Noratlas heavy transport, built under license from France. Westerflug began assembling Vertol helicopters and Noratlas parts.

Gradually the engineers began drifting back to their old jobs. Scientists regrouped in the network of research institutes that had supplied so much

technical knowledge and basic development work to the wartime industry. Slowly, wind tunnels were built, gas dynamics facilities took shape, production lines began to roll, and design groups started to dream again. The industry came alive from head to toe, and started to make up for lost time.

Regrouping of the German aircraft industry has been done along the logical lines of geographical locations. Roughly, the industry is split into halves, one centered in the south on Munich, Stuttgart and Augsburg, and the other, mainly in Hamburg and Bremen. There is a corresponding division of projects, also, the southern unit is regarded as the fighter or light aircraft group, and the northern is considered to be involved with heavy aircraft and transport.

Production of the Lockheed F-104G and the Fiat G.91 will be handled by a special organization—Arbeitsgemeinschaft G.m.b.H.—which includes Dornier, Heinkel and Messerschmitt. But the recent additional order for F-104Gs which raised the total to the 660 mark seems to be beyond the production capability of those three firms alone. It is most likely that the northern group of companies will also get some of the work, in addition to that planned for subcontract to the Belgian and Dutch factories.

German Projects

At a design level, there are several working teams drawn from the top level of engineering staffs in both the northern and southern groups. In these projects lie the future of the German aircraft industry.

Best known of the current design work is that of the next generation fighter, a high supersonic the engineers are talking Mach 3—VTOL airplane under development by a southern team. This project is supposed to be the follow-on for the F-104G, and is scheduled to start service after 1965. How far after depends on a number of things, not the least of which is availability of powerplants.

During last year, two commercial transports found their way to the drawing boards, one at Hamburger Flugzeugbau and the other at Heinkel. The first was a large multi-jet transport directly competitive with advanced Caravelle designs, and the second was a twin turboprop feeder intended as a DC-3 replacement. Both these projects currently are going ahead at a very low rate because of the more immediate problem facing the industry. But preliminary work is nearly completed, and it would not take long for these designs to leave the drawing board.

Hamburger is also working with the French Nord Aviation in the development of a twin-Tyne turboprop transport for German and French military use. This Transall C.160 was proposed as a common solution to the problems of both air forces and armies, but recent reports say that it really suits neither. But the project is going ahead and work leading to the construction of the three prototypes is well advanced.

The German industry has not neglected helicopters or business aircraft. Three helicopters—built by Borgward, Messerschmitt and Bölkow—are currently under development, and a fourth possibility for development in that field lies behind the recent acquisition of a major chunk of Weser Flugzeugbau stock by United Aircraft Corp.

In the business flying area, a whole hatful of interesting and unusual light plane and touring designs have been built and flown during the past year.

Even this outline inventory of Germany's aircraft industry and air force shows their surprising growth and current depth. To attribute all this to the military choice of the Lockheed F-104G is, of course, not correct. But it would be hard to find another single reason that has had as much influence on both military and industrial future growth.

The only question is whether or not the Germans would have accomplished the same results by choosing one of the other fighters up for consideration. This is difficult to argue, because too much is uncertain. But in balance, and considering high levels of the different technologies that Germany bought, it would seem that the Lockheed was the only airplane that could have done all that.

It is almost possible to reconstruct the workings of the German minds that made the decisions, and to list the disadvantages of the airplanes that were rejected. Remember that the problem was to get a modern design that was militarily satisfactory, equal to anything anybody else could get into the air and at the same time, of advanced enough design to give the industry some really modern technologies. Politically, the decision had to satisfy most of NATO.

Under these conditions would you buy from a neutral country or from a country whose aircraft industry was going to compete with your own directly? Would you want to strengthen an engine company that would be selling against your own manufacturers at some future date? Would you buy an airplane that no other service had bought? Would you buy a design study?

Or would you buy an airplane that had been ordered in quantity, that was faster and higher officially than any other airplane, and that would give your industry a flying start along the tough competitive trail it would have to blaze?

The Germans answered those questions in their own way.

Japan's Aviation Industry Gains Strength

By Sol Sanders

Tokyo—Revitalization of Japan's aviation industry has begun and there are indications that 1960 and 1961—while years of modest manufacturing activity—may clear the way for the long awaited reconstruction of what was once one of the world's major aviation centers.

Japan has taken four concrete steps leading to new aircraft, missile and space research programs:

• **Choice of Japan's new fighter,** a problem that had hung over the country for almost two and a half years. Japan will build 200 Lockheed F-104 fighters for its air force in the next five years. The United States is pledged to pay $75 million or 28% of the total cost of producing the fighters—$268,900,000, including spares.

• **Small budget for space research** has been included in the new budget for Fiscal 1960 beginning in April. Minister Yasuhiro Nakasone of the Technology and Research Agency has asked for $3½ million to be used in a program which will mesh with the U.S. National Aeronautics and Space Administration.

• **Japan's long-awaited** turboprop transport project has finally received government endorsement with a $2 million subsidy. The project is a modest one—according to some critics it is too modest—which aims at building a new work horse aircraft (the YS 11) for Asian and African carriers.

• **Program of missile equipping** of Japan's Self-Defense Forces has been laid out which envisions weapons for all branches of the country's armed forces by 1965, and includes plans for Japanese-made weapons. A basis was laid for the program with the delivery in late November of Sidewinders for Japan's North American F-86D and F-86F fighters.

Decision on the next Japanese fighter plane to be put into production was one of the hottest political issues of 1959. In the spring of 1959—after a period of indecision which Japanese manufacturers said had already delayed their switchover from the F-86s to the new fighter—a Defense Agency decision was made for the Grumman F11F-1F Super Tiger. The announcement released a storm of abuse, charges, and counter-charges. Socialist members of the Diet (parliament) charged the decision had not been made on technical grounds but by peddling of "influence." Furthermore, the Socialists charged the question of a fighter in a world dominated by missile warfare was moot.

In June, Prime Minister Nobusuke Kishi withdrew the decision and announced that a civilian council of experts would be chosen to help the Defense Agency reach a new decision. On June 15 the Defense Agency announced the Grumman fighter decision had been scrapped—in part due to the decision of the West German government to adopt the Lockheed F-104G. It was then decided to send a mission to the United States headed by the much respected Gen. Minoru Genda—the chief of staff of the Air Self-Defense Force. Genda and his mission went to the United States where Japanese pilots flew the candidates for the new plane—the Grumman F11F-1F, the Lockheed F-104, the Northrop N-156F, and the F-102 and F-106 interceptors. On his return to Japan Genda recommended the Lockheed plane and the Defense Agency backed him up. The decision has not ended the controversy. A former Navy comrade-at-arms of Genda, Masataka Chihaya, excited considerable comment with "An Open Letter To General Genda" in late November. Chihaya charged Genda had sidestepped the basic issue of whether Japan—limited to defensive weapons alone by the "MacArthur" constitution—should not have abandoned manned aircraft for missiles.

But the decision is definite. Mitsubishi Heavy Industries, Reorganized, Ltd., will be prime contractor with Kawasaki Aircraft Co. subcontractor. Both companies have pledged to move as swiftly as possible to get the plane into production. But early estimates are that assembly won't begin until 1961.

Ishikawajima Jet Engine Plant. Ishikawajima Heavy Industries, Ltd. has undertaken Japan's first postwar aircraft engine production. Last year for the first time, it built three J3s which were delivered to the Defense Agency to power Japan's T1F1 trainers. They are undergoing flight tests. If these tests prove satisfactory, Ishikawajima hopes for further orders for powerplants for 90 T1F1s. There has, however, been no government appropriation for the project.

Meanwhile, the F-86 program is drawing to a close. Mitsubishi has spread out production of the remaining F-86s until the end of this year. By February Mitsubishi had assembled 257 fighters since 1956 with another 43 to go before the program for building 300 in the end of Fiscal 1960 is completed. Kawasaki completed its Lockheed T-33 production last March (210 planes) and will now turn to a Lockheed P2V program (42 planes in the next five years). Fuji Heavy Industries, Inc., will produce the Fuji T1F3 trainer—originally on a program which would total 60 planes but which the Finance Ministry whittled down to 20 aircraft in the budget recently presented the Diet.

Whatever the last word in the Diet, the three major aircraft manufacturers face the prospect of decreased activity during 1960 and perhaps early 1961 until the Lockheed program—with its subcontracts—gets under way. Many of the industry spokesmen are bitter that this delay is largely the result of political manuevering at the highest levels and that the industry's recovery which looked like a solid proposition

NIPPON YS 11 TURBOPROP TRANSPORT

● **JAPAN**

Japan's Air Industry	
Capital assets	$86,000,000
Sales	59,900,000
Profit	850,000
Total postwar investment	47,000,000
Employes	
direct	7,702
indirect	8,705
Manufacturing companies	
Mitsubishi Heavy Industries, Reorganized, Ltd. (Shin Mitsubishi)	
Kawasaki Aircraft Co.	
Fuji Heavy Industries Co., Ltd.	
Maintenance companies	8
Components manufacturers	14

in 1956-58 has taken such a setback.

Some aid may come from a helicopter construction program. Mitsubishi is already assembling the Sikorsky S-55, has produced eight since the program began in 1958, and will make another 11 this year and next year for a total of 30. Kawasaki is making the Bell 47G-2, has completed 22 for the defense agency, exported one to Civil Air Transport of Taiwan (Formosa), and two more have gone to Japanese domestic private users. It will build another 24 during Fiscal 1960 beginning in April of which only two will go to the defense agency and the rest to Japanese private consumers.

Helicopter Choice

A dispute is building up over the production of a heavier helicopter, reportedly because each of the three divisions of the defense agency seeks a different model. The choice seems to revolve around Vertol 107 and the Sikorsky S-61 or S-62. No firm quantity has been fixed, and there has been no figure written into the 1960 budget although a decision is promised in June so that production can start in Fiscal 1962.

A sidelight on the helicopter question is the prestige the defense forces gained during last fall's Typhoon Vera when helicopters were used by Japanese and American military forces stationed in Japan for rescue work. Some Socialist deputies, previously bitterly opposed to the whole Japanese rearmament program, have now suggested stationing helicopter disaster units throughout the country.

Yasuhiro Nakasone, a politician who heads the Research and Development Agency, last year organized a Preparatory Committee for Promotion of Space and Technology and the organization asked for $3.4 million in the 1960 budget. The Finance Ministry, all-powerful ministry of the government, wiped out the total sum but Nakasone was able to persuade Prime Minister Kishi to give the Agency something from the prime ministry's "pocket

money." The total to be spent will be just under $1 million—enough to put a space program on a planned basis for the first time.

The Agency plans to create a Space Science Technology Council for the dispatch of survey missions to the U. S., Britain and other countries. It will seek aid for the Japanese meteorological rocket program, space medicine and physics. The Education Ministry plans to continue its sponsorship of the rocket program of Tokyo University, headed by Prof. Hideo Itokawa. And the Postal Services Ministry is planning to start a project on world-wide relay of television signals through man-made satellites.

The rocket project, started under the International Geophysical Year program in 1958, will attempt this year to launch a two-stage solid propellant rocket to 125 mi. for altitude cosmic ray research. Meanwhile, International Rocket Symposium, scheduled for May 24-28, will have leading scientists from the U. S., Russia and Western Europe.

YS 11 Transport

The semi-government Nippon Aircraft Manufacturing Co. hopes to begin manufacture of its turboprop YS 11 transport before the end of the year. In addition to a $2 million government subsidy written into the budget, $1.5 million will be available in private financing. Negotiations will get under way shortly for the purchase of four turboprop engines from Rolls-Royce.

The present program calls for the manufacture of machine tools in May with actual component parts manufacture to begin in October. Assembly would start, according to the schedule, in March 1961, with the first test flights of prototypes in the fall.

The transport is a joint effort of six companies. Mitsubishi Heavy Industries Reorganized Ltd. will build the fuselage, equipment and wing joint assembly. Kawasaki will build the wings. Fuji Heavy Industries will make the tail assemblies. Shin Meiwa Industries and Japan Aircraft will undertake some subassemblies, and Showa Aircraft will make the tools.

Transport Cost

The aircraft is expected to cost about $1 million each. It will have a takeoff distance of 3,250 ft. and a cruising speed of 249 kt. with a full load of 52 passengers. It will not be pressurized.

The plane's design team includes Jiro Horikoshi, designer of the World War II Zero fighter, and Prof. Hidemasa Kimura.

The YS 11 is a modest product in the days of faster jets and turboprops. But the company believes there is a market for this short-haul plane in the

underdeveloped regions of South Asia and Africa. There has been, however, a notable absence of interest on the part of Japan Air Lines, chief Japanese domestic carrier and the international Japanese flag carrier.

No problem in Japanese politics is so touchy as the rearmament question. The Socialist Party opposes all rearmament and has fought the Liberal Democratic government on every question. However, several political developments have changed the atmosphere. The Socialist Party has split into two groups, the Socialist Party and a new Democratic Socialist Party. The latter takes the position that Japan must have a defense establishment so long as the country faces the menace of the Peking-Moscow alliance.

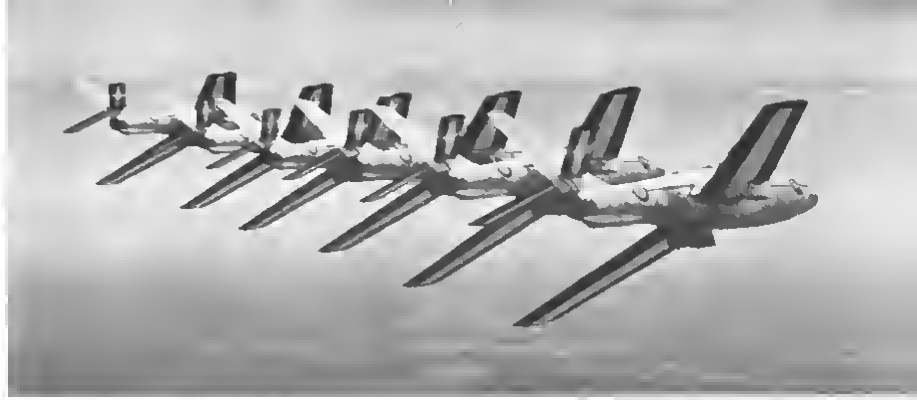
The Self Defense Agency has long recognized the necessity of equipping its forces with missiles. Last November the first Sidewinders arrived in Japan and, contrary to expectation, there was little of the usual highly inflammatory protest demonstrations from the Socialists and the left wing unions.

There also is a dispute brewing in the Diet over the purchase of 42 Chuvair Tartar missiles for the Sea Self-Defense Force (AW Feb. 15, p. 35). The missiles will be bought for delivery in 1961 with funds left over from the Self Defense Forces' 1959 budget. The Socialists are hoping to making an issue out of the use of these funds. The defense agency wants the United States to pay half the cost of a vessel to be launched in 1961 which would carry the Tartars.

The agency has a plan to equip all branches of its forces with missiles by 1965. But there is general recognition that this will depend on the U.S. Mutual Security Assistance Program. It is believed Prime Minister Kishi talked over this problem when he visited Washington early this year for the signing of a revised U.S.-Japan security treaty.

The Agency has asked the Diet in the budget for 1960 to appropriate money to send a first echelon of troops to the U.S. for training in the use of Nike Ajax missiles. The Agency hopes eventually to acquire Hawk and Bomarc missiles. It has its own anti-tank, wire-guided, solid-propellant missile in the research and development stage.

A powerful mission of Japanese aircraft manufacturers and Ministry of International Trade and Industry officials is visiting the U.S. to investigate the possibilities of missile assembly and production in Japan. The mission, headed by Yoshinaga Seiki, president of Mitsubishi Electric Mfg. Co., Westinghouse licensee and one of the most powerful heavy and light electrical manufacturers in Japan, is likely to determine the final outcome of the present missile programing.



ITALY'S RED DEVILS TEAM IN F-84Fs

● ITALY

Italy Seeks New Fighter for Air Force

Italy, faced with the necessity of modernizing its fighter force to meet home defense requirements and NATO commitments is comparing the Lockheed F-104G, Republic F-105 and Convair F-106 as the first step toward selecting a successor to more than 300 aging North American F-86s and Republic F-84s on which the Italian Air Force is still dependent.

Italian government representatives have discussed the F-104 with representatives of West Germany, the Netherlands and Belgium to learn of their experience in evaluation and selection of the Lockheed fighter.

The high cost of the Republic F-105 may discourage the Italians from purchasing this fighter type, the cost to USAF for an F-105D is more than $3 million although Republic is making an effort to bring this down to about $2 million.

During the past year the Italian Air Force formed its first squadron of operational Fiat G-91 light strike fighters supplementing but not replacing, Republic F-84F fighter-bomber units.

The G-91, winner of NATO's light strike fighter competition, also has been adopted by West Germany, Greece and Turkey, but Italy is disappointed that quantity orders for the aircraft have failed to materialize.

The first 25 G-91R reconnaissance aircraft ordered by the Italian Air Force has been completed and component construction has begun for 50 G-91Rs ordered for the West German Air Force. The G-91 may be built in West Germany under license, if so, Dornier Werk GmbH is expected to be given responsibility for final assembly and flight

FIAT G-91 STRIKE FIGHTERS

PIAGGIO P.166 EXECUTIVE PLANE

test. Production of two-seat G.91T trainers also was begun in the past year at Fiat's Turin factory.

The first production models of Italy's primary jet trainer, the Macchi MB.326, are being used for flight test and initial pilot training, and the aircraft is well into production.

Navy Airpower

Italy will receive Grumman S2F-1 anti-submarine warfare aircraft under the U.S. Mutual Assistance Program. Present plans call for three squadrons each containing 12 of the twin-engine Trackers.

When they become operational the S2F-1s will be under Italian navy staff command but will be flown and maintained by the air force.

Grumman is building S2F-1s for Italy and the Netherlands under a $16,200,000 contract from Bureau of Naval Weapons.

A small quantity of Sikorsky HSS-1 anti-submarine warfare helicopters also will supplement the Italian navy's forces.

In the Italian helicopter field, Agusta is producing Bell 47J and 47G-2 utility helicopters under a license which it has had with the U.S. helicopter manufacturer since 1952. Agusta probably will change its production lines this year to build the new 47J-2 and add the supercharged 47G-3 to the 47G-2 line.

European Sales

Agusta's sales territory covers continental Europe. It has sold more than 300 Model 47 helicopters since 1952 to the Italian government and in 12 other countries. It currently is putting two prototypes of a nine-place utility helicopter, patterned after the Bell YH-12, through type certification and has also developed a small one- to two-place helicopter which uses a Bell-developed rotor system.

The company also is working on a flying crane project designed for a payload of 8.12 tons. Mission requirements were specified by a military group comprising representatives from Italy, Germany and France. The Agusta flying crane proposal would be powered by three General Electric T58 turbine engines.

Agusta's total employment is approximately 1,600. The company also manufactures motor vehicles, from trucks to small scooters.

Aeronautica Siculа S.A. will produce Douban LZ-5 helicopters at Palermo. The first 10 LZ-5s will be operated by Sicilian Airlines in scheduled passenger service and for charter assignments. An additional 20 LZ-5s will be built for the U.S. market.

Fiat's cold-jet helicopter, the 7002, is expected to begin flight test this

spring. Static and dynamic tests are largely completed. Powerplant is a Fiat gas generator unit developing about 530 shp. for takeoff, and delivering about 7.5 lb./sec. of air to the cold jets at the blade tips.

Licensing Agreements

Hamilton Standard Division of United Aircraft Corp. recently completed negotiations to purchase half interest in Microtecnica, Inc., of Turin, producer of navigation instruments, optical and mechanical testing instrumentation, servomechanisms and synchromechanisms. Microtecnica will manufacture individual items of jet equipment under license from Hamilton Standard.

Lockheed Aircraft International acquired a large stock interest in Aeronautica Macchi of Varese and made an agreement to license production of Lockheed's Model 60 high-wing light utility aircraft (AW Nov. 23, p. 33).

First Model 60s are expected to come off Macchi's production line by late summer.

Informal cooperative agreements have existed between Lockheed and Macchi since 1957, and the Italian company overhauls and manufactures spare parts for Lockheed T-33 trainers.

Italy also is making progress toward completion of operational missile bases. Nike Ajax and Nike Hercules anti-aircraft missile squadrons have finished training at the U.S. Army Guided Missile School at Ft. Bliss, Tex., and are deployed in northern Italy.

Construction is being completed on Italian launching sites for Jupiter intermediate range ballistic missiles, and training of Jupiter squadrons is well along.

Deployment of IRBMs on the Italian peninsula has moved from the planning stage to an actuality, and training and construction is currently in progress.

Collaboration Discussed

The Italian National Research Council's seven-man Commission for Space Research has discussed with National Aeronautics and Space Administration the possibility of collaboration between Italian and U.S. scientists in space research. The commission has been given responsibility for accelerating Italy's space research work. The commission is headed by Luigi Broglio, University of Rome professor of aircraft construction.

Italy's Red Devils six-man aerobatic team won acclaim for its precision flying in F-84Fs at the World Congress of Flight at Las Vegas, Nev., in April. The team was asked to extend its visit for a month so it could tour USAF bases, giving demonstrations of precision formation flying.

NASA Creates Life Sciences Division

Vigorous program planned by fifth major office, which will handle biology, medicine, psychology.

By Evert Clark

Washington—National Aeronautics and Space Administration last week created a fifth major headquarters division to handle space biology, medicine and psychology and prepared to build toward a vigorous, wide-ranging national life sciences program. Director of the new Office of Life Sciences is Dr. Clark T. Randt.

Creation of the office, predicted by AVIATION WEEK last Jan. 4 (p. 27), resulted from a survey of national life science capabilities made last year by a seven-man committee headed by Dr. Seymour S. Kety, chief of the clinical science laboratory at the National Institute of Mental Health.

The committee found the U.S. badly lacking in space life sciences capability, in spite of the "excellent quality" of current military and industrial bioscience programs, and said the number of biological, medical and psychological scientists qualified for and interested in space research "is at present seriously limited."

Initially, NASA will rely heavily upon existing military aeromedical facilities and on contracting with industry and universities. It is not expected to try to annex any existing facilities, as it did in the propulsion field when it took over Army's missile development facility.

Intramural Program

The Kety committee report urged that NASA begin immediately to build a strong intramural life sciences program and, at the same time, plan to stimulate and support a strong extramural program through research contracts, grants and extensive training programs.

It also recommended that NASA build a large main research facility, to be located in Bethesda, Md., near the National Institute of Health, or at Greenbelt, Md., near NASA's Goddard Space Flight Center and Department of Agriculture Research Laboratories.

NASA Administrator T. Keith Glennan is expected to accept most, if not all, of the major Kety recommendations. No facilities are expected to be built until after the Fiscal 1962 budget goes into effect in July of next year. Although the committee did not conclude its survey until after NASA's Fiscal 1961 budget had been formulated, the agency does not now expect to ask for a supplemental appropriation to support the life sciences program.

Observations made by the committee included:

▪ "The present research effort in this (life sciences) field within NASA appears to be concentrated upon a single specific goal, exemplified by Project Mercury (man in space), at the possible expense of broader, more remote but fundamental aims."

▪ "The remainder of the national space biomedical effort is found in the military, industrial and academic laboratories is sporadic and incidental to other primary interests or responsibilities."

These efforts are, on the whole of excellent quality and should be maintained and supported; there is need however, in addition to these and coordinated with them, for a broad and thoughtfully planned biomedical program of research extending from the most fundamental aspects to their most practical applications.

The nucleus of such a national undertaking should be the NASA intramural program."

▪ "The number of competent biological, medical and psychological scientists motivated toward space research and skilled in its special problems and techniques is at present seriously limited. It is necessary to create a number of career opportunities in these fields on a long term, full time basis and to increase the number of laboratories and facilities in which post-graduate training for such careers may be accomplished."

Satellite Needs

A satellite and probe program in which "a significant number of payloads would be dedicated primarily to biomedical purposes" should be "initiated shortly and projected indefinitely," the committee said.

These should be engineered from their inception with biological purposes in mind as opposed to the present opportunistic 'space available'—'non-interference' provision."

The committee said NASA "has so far concentrated almost entirely on the physical and engineering aspects of flight problems" has the responsibility but not the authority, in dealing with the services on NASA's Mercury program, and is using military facilities that appear to be in excess of military needs but may not always be.

The services have just completed surveys of their own in which they matched current and future bioastronautics requirements against existing facilities.

Dr. Randt is the only officer named to the new division thus far. The Kety group, formally known as the Bioscience Advisory Committee, recommended that there be assistant directors for basic biology, applied medicine and biology, medical and behavioral sciences and the extramural program.

Randt, 43, served as the committee's

USAF Plans BMD Management Firm

Washington—Air Force is drafting plans for the organization of a non-profit corporation to provide technical direction and systems engineering for Ballistic Missile Division weapon systems—tasks now conducted primarily by Space Technology Laboratories.

The new corporation, which probably will be located in southern California, is expected to draw heavily upon technical personnel now employed by Space Technology Laboratories, particularly members of the STL advanced planning group with STL's permission.

USAF may initially require approximately 500 technical employes, the bulk of them from STL, and later will add personnel to fill out the corporation's technical and administrative staff.

STL top personnel probably will retain its management functions in the Atlas, Titan and Minuteman ICBM weapon systems, with the Air Force corporation taking over as new projects come along. STL also will continue as a profit-making corporation, probably bidding on defense contracts that fall within its field.

The Air Force move is aimed at putting an end to criticism by Congress and segments of industry over USAF's reliance on STL—a subsidiary of defense contractor Thompson Ramo Wooldridge—for technical direction of its ballistic missile programs. Congressional criticism has included demands that STL be converted into a non-profit institution. (AW Sept. 14, p. 146)

executive secretary and wrote its report. He joined NASA last July, a month before the committee was formed, as scientist for space medical research. He was graduated from Colgate University and earned his medical degree from Western Reserve University in 1943. His training is in internal medicine, military psychiatry and neurology. Randt joined Western Reserve's medical faculty in 1950 and became associate professor of neurology there in 1952. In 1956, he was named director of the neurology division at the University Hospitals of Cleveland, Ohio. His current research, NASA said, has been concentrated in sensory deprivation, particularly in the areas of weightlessness, isolation and confinement.

In addition to recommending that NASA take leadership in formation of a national life sciences program using the services to the fullest extent possible, the committee said that NASA should:

- **Establish the life sciences research center** in order to help develop a capability for research peculiar to its own needs.
- **Appoint an advisory committee** to the director of life sciences composed of outside consultants.
- **Assume "proper responsibility** for education and training in the space oriented life sciences through postgraduate fellowships, training grants to institutions and short-term visiting scientist appointments to be integrated with other NASA efforts in this area."
- **Place special emphasis** on "the free exchange of scientific findings, information and criticism among all the scientists."
- **Exercise security regulations** "with great caution" and limit them to "matters in which national security is clearly involved."
- **Consider life sciences' facilities** to be a public trust in implementing national and international cooperative efforts."

Business Leaders Warn of Soviet Threat

By Ford Eastman

Washington—Four leading American businessmen have warned a congressional investigating committee that the U.S. is facing its most serious challenge in decades in the Soviet bid for world domination and must be prepared to win the race at all costs.

The businessmen, all Republicans familiar with government problems, said the U.S. must accelerate its defense efforts, improve national defense policy machinery and be willing to accept any sacrifices necessary to win the race.

The four appearing before the Senate Government Operations Subcommittee on National Policy Machinery headed by Sen. Henry M. Jackson (D.-Wash.), were:

- **Robert A. Lovett**, former Defense Secretary and a partner in Brown Brothers, Harriman & Company, New York investment bankers, and chairman of the executive committee of Union Pacific Railroad Co.
- **Robert C. Sprague**, chairman of the Sprague Electric Co., who served as director of the Gaither Committee when that group reported to the White House on the status of the nation's defenses.
- **Dr. James P. Baxter, III**, president of Williams College and a member of the Gaither Committee.
- **Thomas J. Watson, Jr.**, president of International Business Machines Corp.

Lovett, who offered several suggestions for improvement of the national defense policy machinery, said national security "depends on our belief in the future. It depends greatly on our sense of values and it depends on our willingness to give a little of today in order to have a tomorrow."

The former Defense Secretary added that the U.S. can do whatever must be done in order to survive and meet any form of political or economic competition it is likely to face if it is willing to do its best.

Lovett's suggestions include the following:

- **Defense Department** and its military establishments should be non-political and non-partisan. This, he said, should apply to civilian department heads as well as the military.
- **Military policy** and strategic planning require a prior step—the determination of a national political policy. Military professionals should contribute to, but not originate, policy, but they cannot do their planning job until a higher level fixes national goals.
- **"Number of committees** in the Defense Department and the military departments is still far too great. There is excessive staff layering."
- **"Authority of the individual** executive must be restored. Committees cannot effectively replace the decision-making power of the individual who takes the oath of office.
- **Civilian and military executives** should stick to the fields in which they have special training and aptitudes.
- **"Split papers"** from the Joint Chiefs of Staff should not be regarded as inherently objectionable. It is vitally important to the Defense Secretary to know the alternatives or obstacles to a proposed program to aid him in reaching a decision.
- **New cabinet post** should be created to handle foreign affairs and relieve the Secretary of State of the burden of attending meetings and conducting negotiations. This would permit the Secretary to devote more time to national policy problems.
- **State and Defense departments** should participate fully in the initial establishment of budgetary guidelines for national security programs to determine what is necessary, whether it is feasible from the viewpoint of production and resources and whether it is socially or politically acceptable to the people. He also cited the importance of having budgetary goals determined at the outset on the basis of national need rather than by officials of the Budget Bureau.

Dr. Baxter said that Russia, by spending 25% of its national income on the military effort and combined with impressive improvements in their Soviet science and technology, confronts the U.S. with a "most serious challenge in diplomacy, trade, economics and military power, from the Caribbean to outer space."

He warned that the U.S. must not let its defenses fall behind in any area, although its military force is the world's most powerful at the present time. He said the U.S. should also continue economic and military assistance to its

Saturn Bidders

Washington—Eleven companies submitted bids last week for development of the S-IV stage for the Saturn space vehicle. National Aeronautics and Space Administration is expected to select a winner before April 1.

This stage will be powered by four 200,000-lb.-thrust Pratt & Whitney XLR-115 hydrogen-fueled engines furnished by the government. Contract for the engines is being negotiated. This and all other Saturn upper stages will use balloon tankage as predicted by Aviation Week (Jan. 18, p. 28).

The S-IV stage will form the second stage of the earliest three-stage Saturn designated C-1. It will form the third stage of the later four-stage C-2, and the fourth stage of the final five-stage C-3.

Twenty companies were invited to the bidders' conference (AW Feb. 1, p. 18) and about 35 attended. Those submitting proposals were Martin, Convair, Bell, Chrysler, McDonnell, Grumman, North American, Boeing, Douglas, United Aircraft and Lockheed.

allies and increase its assistance to underdeveloped nations of the world.

Dr. Baxter said he realized his suggestions would cost large sums of money, but added "there are things the American people spend a lot of money on that they well could do without or have less of, in exchange for greater security. . . I am willing to pay more taxes if it is necessary to do the things we need to do, and I believe that our entire people would feel the same way if they realized all that is at stake."

Sprague told the committee that advancing military technology is rapidly "precipitating us into an unstable security position."

He added that he had given a "great deal of prayerful thought during the past seven years" to these problems and emphasized these points:

- "The nation faces a clear and imminent threat to its survival, but we have not yet fully awakened to this very unpleasant fact.
- "The nation can and should do much more to put its back into the job of meeting the threat. We certainly have the resources to do those things required for our survival, provided we allocate them wisely.
- "Key officials concerned with our national security frequently do not have all the facts they need to make many important decisions, or they have the wrong facts.
- ". . . Our key officials, particularly the Secretary of Defense need better staff assistance for securing objective military advice.
- "The Congress should, by appropriate legislation, give the President and the Secretary of Defense more flexibility in assigning roles and missions to the three services and to the Marines.
- "The Congress could and should play a more active role in stiffening our response to the Communist challenge."

Watson said the U. S. cannot go along with "business as usual" and hope to win the race with the Soviet Union but must be prepared to throw "our economy into full scale competition with the Russians—meeting their challenges whenever and wherever they occur." One of the first sacrifices he said, must be a willingness to accept higher taxes, if necessary, to keep the U. S. ahead.

Watson also told the committee:

- "Our national goal should be clear superiority over the Soviet Union in all possible areas and we should believe enough in our democracy so that we will not be reluctant to fully enter the contest.
- "We must be coldly realistic about Soviet successes and our own and balance one against the other to evaluate where we stand.
- "We must cultivate an atmosphere which will foster the type of creative and unorthodox thinking necessary to find effective solutions to the Soviet problem.
- "We must eliminate or cut back all programs of government spending which our common sense tells us can not be tolerated in an emergency.
- "We must balance our budget and even strive for debt reduction. To do this may well require more taxes for we must spend more in the areas where the Soviets are ahead in moving up.
- "Our foreign aid programs must be held at reasonable levels until the underdeveloped nations are economically independent. We must realize that we invest here in our enlightened self interest and not for charity."

Symington Renews Debate on Defense

Washington—Sen. Stuart Symington (D-Mo.) last week singled out for attack the President's declaration in a nation-wide television presentation that "as for longer range ballistic missiles from a standing start only five years ago we have literally leaped forward in accomplishments no less than remarkable."

"It is not a question of a 'standing start' in 1955, rather a 'slow down' in the years since then," Symington declared in a Senate speech, responding to an earlier speech by Sen. Everett Dirksen (R-Ill.), minority leader, which highlighted the President's "standing start" observation and placed blame for the missile gap with the Democratic Administrations in the years before 1953.

"The present relative disadvantage of this country in the ICBM field arises from one cause and one cause only—the refusal of this Administration to put up the money for any real production after the missile had been developed," Symington said. He pointed to the testimony of Dr. Herbert York, Defense Department director of research and engineering, before the House Appropriations Committee in January, during which York testified that the U. S. is behind the Soviet Union in the field of intercontinental ballistic missiles "in terms of numbers of missiles only, not in terms of development."

Symington also took note of Dirksen's charges that during his years as Secretary of the Air Force in the Truman Administration he had favored economy in defense spending.

"My point was, and of course still is, that all government budgets should be reviewed carefully, but the final decision should be made on the basis of what is necessary for adequate national security, and not on the basis of what will satisfy a fiscal objective," Symington told the Senate.

Jets, Seasonal Ebb Cited in Pilot Layoffs

New York—Increased fleet efficiency through turbojet and turboprop transports and a seasonal ebb in traffic volume were cited by Pan American World Airways, Inc., Eastern Air Lines, Inc., and National Airlines, Inc., as reason for furloughing more than 250 pilots.

The 115-pilot cutback on the part of Pan American may be the first major instance in which jet transports played a dominant role in forcing technological unemployment of airline pilots.

With 23 jet transports in its fleet, Pan American disclosed last week that it is releasing 55 "active" pilots from the bottom of its 1,563 pilot seniority list on Apr. 15. Furloughs effective May 1 will pare 60 additional pilots from the current company roster. Several more Pan American pilots on extended leaves of absence also will be furloughed.

Employing 1,946 pilots—more than any other carrier—Eastern last week confirmed that furlough notices effective Apr. 1 had been mailed to 107 company copilots. The carrier denied, however, that the cutback in pilot strength was attributable to jet transports, terming it "seasonal in nature."

Eastern averages eight flights daily with its four Douglas DC-8s.

Last month, Eastern halted the training of 26 mechanics who were taking the company's flight engineer upgrading course. Within another month the carrier plans to send furlough notices to 50 qualified flight engineers—anticipating the sale, lease or retirement of a sizable number of Lockheed Constellation 749 and 1049 series aircraft.

On Mar. 11 and 12, furloughs will cut 30 pilots from National's seniority list which now includes 322 pilots. Company spokesmen said deliveries of Lockheed Electras, a seasonal ebb in traffic on National's New York-Miami route and the sale of the carrier's entire Convair 340 fleet were the reasons behind the layoff.

Senior Pan American pilots queried by AVIATION WEEK listed these three factors as being responsible for their company's timing of its furlough introduction of jet transports with attendant increases in the number of passenger seat miles per pilot available to the carrier; heightened competition from foreign flag lines operating on Pan American's international routes, and the disposition of piston-driven equipment.

Deliveries of seven Pan American Douglas DC-6Bs leased to Capital Airlines, Inc., began in January and should be completed this month. Capital has taken options to lease four more Pan American DC-7s plus options to purchase all 11 aircraft.

IATA Emergency Meet Indicates Higher North Atlantic Jet Fares

Paris—Higher air fares on jet North Atlantic flights may result from the International Air Transport Assn emergency meeting which began here last month.

IATA carriers, after agreeing to prolong current North Atlantic air fares until May 1, last week still were discussing what sort of fare structure on the North Atlantic should come into being after that date. Despite preconference predictions of lower basic fares, reports slipping out of the closed meeting indicate just the opposite.

This was how North Atlantic fare structure seemed to be shaping:

- **Jet first class fare** from London to New York would rise from $440 one way to $500 one way. This last figure is what most first class jet passengers currently pay since on top of their first class ticket they are charged $60 for de luxe service. Thus carriers seem to be eliminating the de luxe service distinction by incorporating the charge as a permanent part of the basic first class structure. After May 1 no jet surcharge would be levied.
- **Jet economy service** from London to New York one way would be fixed at $272 in place of the current $257. The proposed $15 increase really represents the current jet surcharge levied on jet economy flights. Thus carriers seem to be making the surcharge a permanent part of the basic economy jet fare.

Other North Atlantic fare proposals would create a separate fare structure for propeller aircraft. First class propeller fare one way between New York and London would be $440 as compared with the proposed jet first class fare of $500. First class propeller fare with sleeperette would be $500.

Elimination of tourist fares on all jet flights is also proposed. Latter would offer just two fares: first class or economy. North Atlantic propeller flights, however, would still be permitted to offer tourist fares as well as first and economy.

Informed observers warned that none of these proposals had yet found the necessary unanimous backing from the carriers. It was also pointed out that while the North Atlantic basic fare structure seems to be edging upward, various carriers still intended to introduce lower North Atlantic fares.

Trans World Airlines, for example, is expected to push for a special 17 day excursion jet fare between New York and London of $312. TWA fare would be applied during off season months and would represent a reduction of $150 over the current minimum round trip jet fare between New York and London. Others were reportedly preparing similar plans to be discussed by the meeting.

Special gathering of the international carriers was necessitated by failure to reach agreement on certain international fare structures at the regular IATA meeting in Honolulu last fall. At stake in the current IATA meeting are new fare patterns not only on North Atlantic routes but on mid-Atlantic routes, European routes to Africa and the Far East and also transpacific routes. Rates on these segments expire Mar. 31. After that date, if no agreement is reached by IATA carriers, the situation in these areas would be theoretically open. The Paris emergency meeting was called to head off an open rate situation.

The fact that IATA carriers last week agreed to extend the North Atlantic fare deadline one month was indication that it is this area that presents the most difficulties. The Mar. 31 fare deadline still applies on other routes under discussion. Here the major obstacle seems to be BOAC's determination to introduce fares on Europe to Africa and Far East routes which would be from 10-20% below current tourist rates on these routes.

Space Technology

Project Orion Funding in Doubt

Washington — Responsibility for Project Orion feasibility studies, refused by the National Aeronautics and Space Administration, is being offered to the Air Force by Defense Department's Advanced Research Projects Agency.

Project Orion is an ARPA investigation of the possibilities of launching space platforms weighing 1,000 tons into space by exploding small nuclear bombs behind them (AW Feb. 29, p. 26).

In another development, project officers for nuclear rocket propulsion urged earlier use of nuclear space propulsion than is currently planned and said that a nuclear rocket booster could be ready for space flight by the mid-1960s and that nuclear propulsion could be available to help send a manned expedition to the moon before 1970 if the program was speeded up.

Defense Department is preparing to transfer Project Orion from ARPA to the Air Force, William H. Godel, ARPA director of policy and planning, told the House Space Committee. Only current obligated funds will be transferred with Orion, however, since the study contract with the General Atomics Division of General Dynamics Corp. is funded only through August.

Since no new money has been requested to carry the studies beyond August, Godel said, the Air Force probably would get the necessary funds to continue the program by reprogramming other activities. He estimated that $15-$19 million would be needed during the next year to prove certain critical components of the entire system. It is currently funded at a rate of $100,000 a month, and a total of $2.4 million has been spent to date.

In a letter to NASA asking that it consider transfer of the project to the space agency, Dr. Herbert York, Defense director of research and engineering, said the major concern over the program lies in the future funding level, which has not been established in Defense Department. He said about $900,000 in supplemental funding for fiscal 1960 was considered but rejected because ARPA does not have the resources to carry on the program at the increased level.

Turning down the transfer to NASA, Richard E. Horner, associate administrator, said that although the Orion propulsion device "embraces a very interesting theoretical concept it appears to suffer from such major research and development problems that it would not successfully compete for support in context of our entire space experimental program."

Horner said it would be "extremely difficult" to divert funds from nearer term projects to support Orion, which is considered a longer term project.

Among other uncertainties," he said, "is the question of political approval for ever using such a device seems to weigh heavily in balance against it."

Godel told the committee that he felt the program was worth pursuing as a long-term, very advanced research project by NASA, but that there was also the possibility of developing a military requirement for such a device.

Brig. Gen. Irving L. Branch, chief, joint Defense Department and Atomic Energy Commission office of aircraft nuclear propulsion, told the committee that nuclear propulsion could be available for space projects within the next five years. He said the Rover system could be developed and demonstrated in actual use in a shorter time period.

'Leapfrog' Concept

Washington—Philosophy of attempting to "leapfrog" Soviet Space capability has prevailed in National Aeronautics and Space Administration's approach to U S-Soviet space competition, and this new approach is evident in the decision to accelerate and expand the Saturn booster program, according to Milton W. Rosen, assistant director for vehicles in NASA's Office of Launch Vehicle Programs

Rosen told an American Rocket Society meeting here that "it is obvious we are in a vigorous competition in our field" and that "most of us in NASA have recommended in the past year a procedure of trying to leapfrog our competitor." Rosen said this philosophy involves "putting our blue chips on future programs rather than concentrating on immediate goals and said Administrator T Keith Glennan and most of the NASA staff support this approach

Rosen said "we would be naive if we did not assume" the Russians will have advanced their capabilities by 1964 when the Saturn C-1 vehicle is to be ready, but "we must hope we can move faster than they"

than "requirements stated thus far have indicated a need for"

Gen Branch said he was not satisfied with the emphasis NASA has placed on nuclear propulsion and that he feels NASA should come up with a requirement in the near future to match the capability available

News Digest

McDonnell Aircraft is considering a commercial version of its Model 119 executive jet transport, possibly powered by General Electric CF700-1 turbofan engines (4,000 lb thrust), and designated the McDonnell 220

Voice communications were relayed between New Jersey and receivers in Massachusetts and New York in the third suborbital test of a 100 ft inflatable sphere National Aeronautics and Space Administration plans to launch an identical sphere into orbit with a Thor Delta this month under Project Echo

Air Force plans to fire a simulated warhead 9,000 mi from Cape Canaveral, Fla, with a USAF-Convair Atlas ICBM was postponed last week, reportedly for political reasons After ordering the flight, which would have impacted in the Indian Ocean several hundred miles south of Madagascar Defense Department officials reportedly decided to check with President Eisenhower and were told such a flight would be ill-advised during his tour of South America

Australian government has reversed its earlier position and granted operating rights into Sydney to the French carrier, TAI In return, Qantas was granted operating rights either to Paris, as a terminus from Sydney, or Marseille as a stop between Sydney and London

Federal Aviation Agency last week announced the allocation of $58,835,103 for airport improvements in its federal aid to airports funding for Fiscal 1961 Largest segment will cover runway construction at a total cost of more than $24 million Second largest amount, $21 1 million, is scheduled for taxiway and apron construction, while $6 1 million will be used to acquire land for airports Total of 314 airports is involved

Arabian American Oil Co will phase out its three Douglas DC-6 transatlantic weekly schedules by the end of this year, due to competition of commercial jet transports Aramco employes can elect to fly jets and this is expected to lure increasing numbers away from the company planes

North American Aviation Secretary and Assistant Treasurer Samuel G. Anspach died Feb 24 at his Los Angeles home after a long illness He was 64

Hunting-Clan Air Transport, Ltd., and Airwork, Ltd, have agreed to a merger which will result in formation of the largest British independent airline

Cessna Aircraft President Dwane L. Wallace last week announced that arrangements have been made for Cessna to obtain a minority interest in Avions Max Holste, Reims, France, confirming AVIATION WEEK's exclusive story (Feb 15, p 33) that the two companies were discussing exchange of license rights Max Holste simultaneously confirmed the discussions in France

Frederick B Ayer and Associates will act as U S and Canadian sales agent for American Airlines' used Douglas DC-6s and the airline will handle its own sales in other parts of the world Under the previous agreement of April, 1959, Ayer was committed to take over and dispose of the aircraft over a period of about three years

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73—United Press, 117—Tass; 157—(tables) Ray & Ray

(Continued on page 336)

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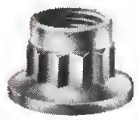

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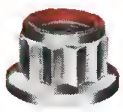

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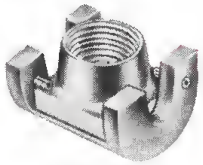

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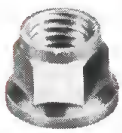

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